NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Technical Report No. 32-998

Planetary Spectra by Fourier Spectroscopy I: Mars

P. Connes

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JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

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National Aeronautics & Space Administration

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ABSTRACT

Mars spectra, obtained during the spring 1965 apparition by interferometric spectroscopy, are presented. A brief discussion is included, together with a summary of the format used to characterize the individual spectral traces. Tables, covering the observing conditions at the time the spectra were taken, are also included.

I. INTRODUCTION

The spectra reproduced for this Report were all taken during the spring 1965 apparition of Mars in the months following opposition. These spectra were taken with a Fourier interference spectrometer at the Coudé focus of the 195-cm telescope, Haute Provence, France.

The interferometric spectrometer used for these observations was developed by P. Connes at JPL (see JPL SPS No. 37-30, Vol. IV, p. 8). It was loaned to the United States Air Force Cambridge Research Laboratories, who provided it to P. Connes for use at Haute Provence on an Air Force contract with CNRS (Centre National La Recherche Scientifique) of France. Improvements in the optical system were made before these observations were started. R. Beer of JPL spent some time at Haute Provence, assisting with these observations.

The computer program for the reduction of the interferometric data was developed by J. Connes while she was at JPL. Data reduction for these observations was carried out at the computing center of Meudon Observatory, Bellevue, France.

II. DISCUSSION

The spectra of the planet are presented, together with comparison spectra of direct sunlight. In general, the solar spectra were acquired under different atmospheric conditions than existed on the nights that the Martian observations were made. Caution should therefore be exercised in the neighborhood of water vapor lines. Caution should also be employed in the general use of these spectral traces. The primary data are generated in digital format and are plotted here via a digital-analog converter. Therefore, for the most accurate investigations, the digital output should be employed. In particular, no allowance has been made on the frequency scale either for finite aperture effects or for the refractive index of the atmosphere. These corrections are generally small but are non-zero.

III. SUMMARY

A summary of the format of the tracings is as follows:

1. *Ordinate:* Relative intensity. The intensity scale is normalized such that the highest peak in the spectrum $\equiv 1.00$. Intensities may be read to approximately 1% of full scale. The intensity scale ranges from -0.25 to $+1.00$. The negative values are necessary to allow for the fact that the interferogram reduction technique can result in small values of apparently negative intensity. *Such values should not, in general, be interpreted as the detector radiating to the planet.* The effect is particularly pronounced in unapodized spectra.

2. *Abscissa:* Frequency. Frequencies are given in cm^{-1}. The reading accuracy may be expected to be 0.1 cm^{-1} or better.

3. *Noise Level:* The noise level may be estimated by examination of the spectrum in regions where it is known that there is no signal, that is, outside the bandwidth of the isolating filter.

4. *Reproducibility:* The reproducibility of spectral features may be inferred from those spectral traces in which more than one spectrum is overlaid. Different spectra were often taken, with many days between observations.

5. *Displacement:* Solar and Martian spectra are presented with a physical displacement on the chart corresponding to 0.25 on the intensity scale. Care should be taken to use the correct zero line for each set of spectral traces.

6. *Spectrum Numbers:* The numbers refer to a spectrum numbering system set up for the experiment. They have no general significance except to indicate the order in which they were taken and to act as references. *These numbers should be cited in any query.*

APPENDIX A

Observational Tabular Log

This Appendix comprises an observational log (series 1) and an observational log (series 2), as included in Tables A-1 and A-2, respectively, which follow.

Table A-1. Observational tabular log (series 1)

Source	Spectrum Numbers	Date	Time (U.T.)		Comments
			Begin	End	
(a) *Mars* (upper curves)					
	239	1965, 26–27 Mar.	00H18	03H25	Equal value
	250	1965, 28–29 Mar.	00H55	03H15	
(b) *Sun* (lower curves)					
	258	1965, 23 Apr.	07H59	08H32	
Series 1: 5700 cm^{-1} — 6946 cm^{-1} *Resolution*: ~1 cm^{-1}; spectra apodized					

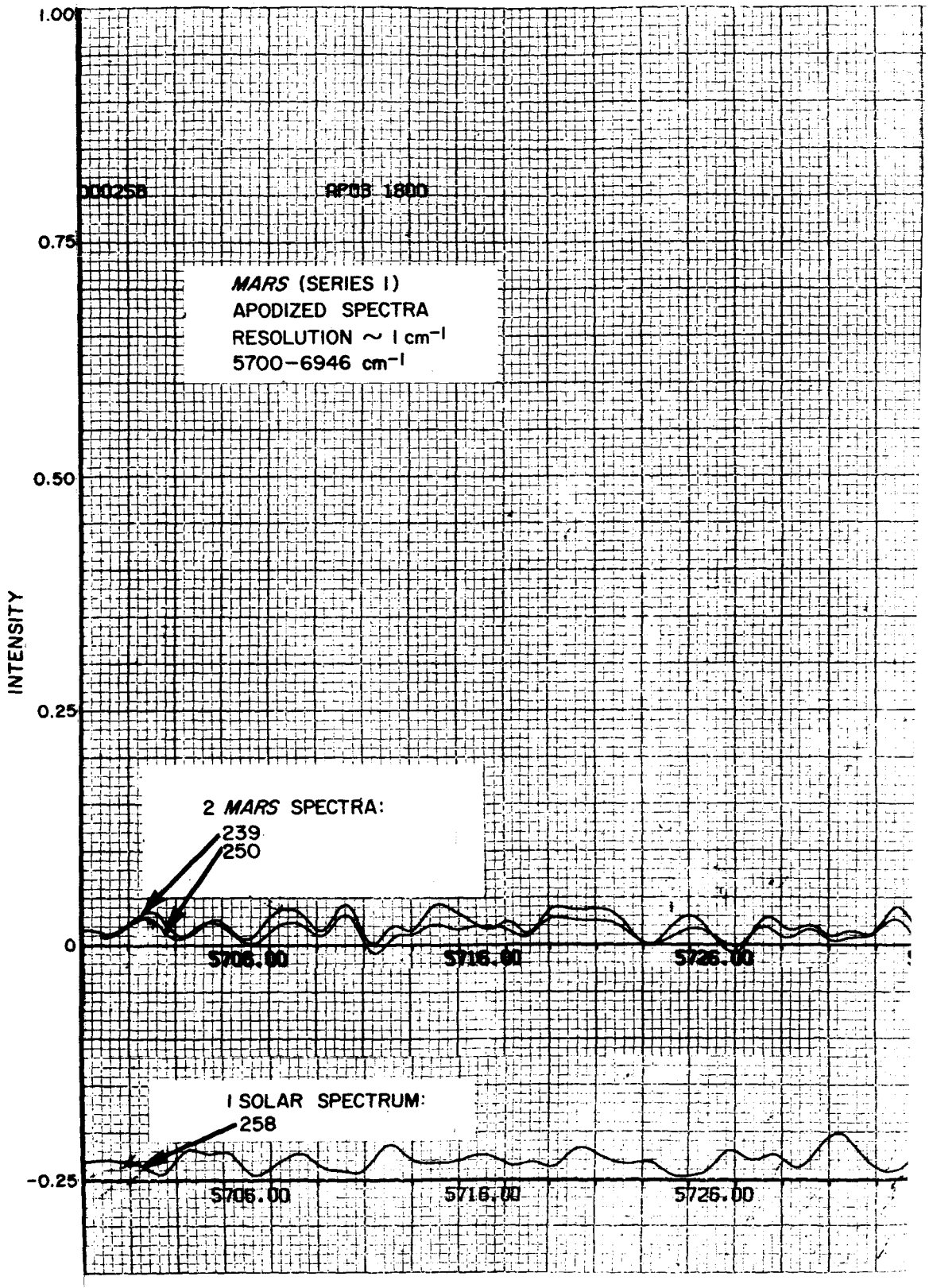
Table A-2. Observational tabular log (series 2)

Source	Spectrum Numbers	Date	Time (U.T.)		Comments
			Begin	End	
(a) *Mars* (lower curves)					
	252	1965, 20 Apr.	18H53	20H00	Equal value
	253	1965, 20 Apr.	20H05	21H27	
(b) *Sun* (upper curves)					
	256	1965, 22 Apr.	11H06	11H37	Slightly inferior to 259-260 because of thin cirrus clouds
	259	1965, 23 Apr.	8H44	9H03	
	260	1965, 23 Apr.	9H08	9H27	
Series 2: 4000 cm^{-1} — 4976 cm^{-1} *Resolution*: ~ 2 cm^{-1}; spectra *not* apodized					

APPENDIX B

Mars Spectra

This Appendix comprises the Mars spectra. The following pages are facsimiles of the spectra in several foldouts of the two series.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RESOLUTION ~ 1 cm⁻¹
5700–6946 cm⁻¹
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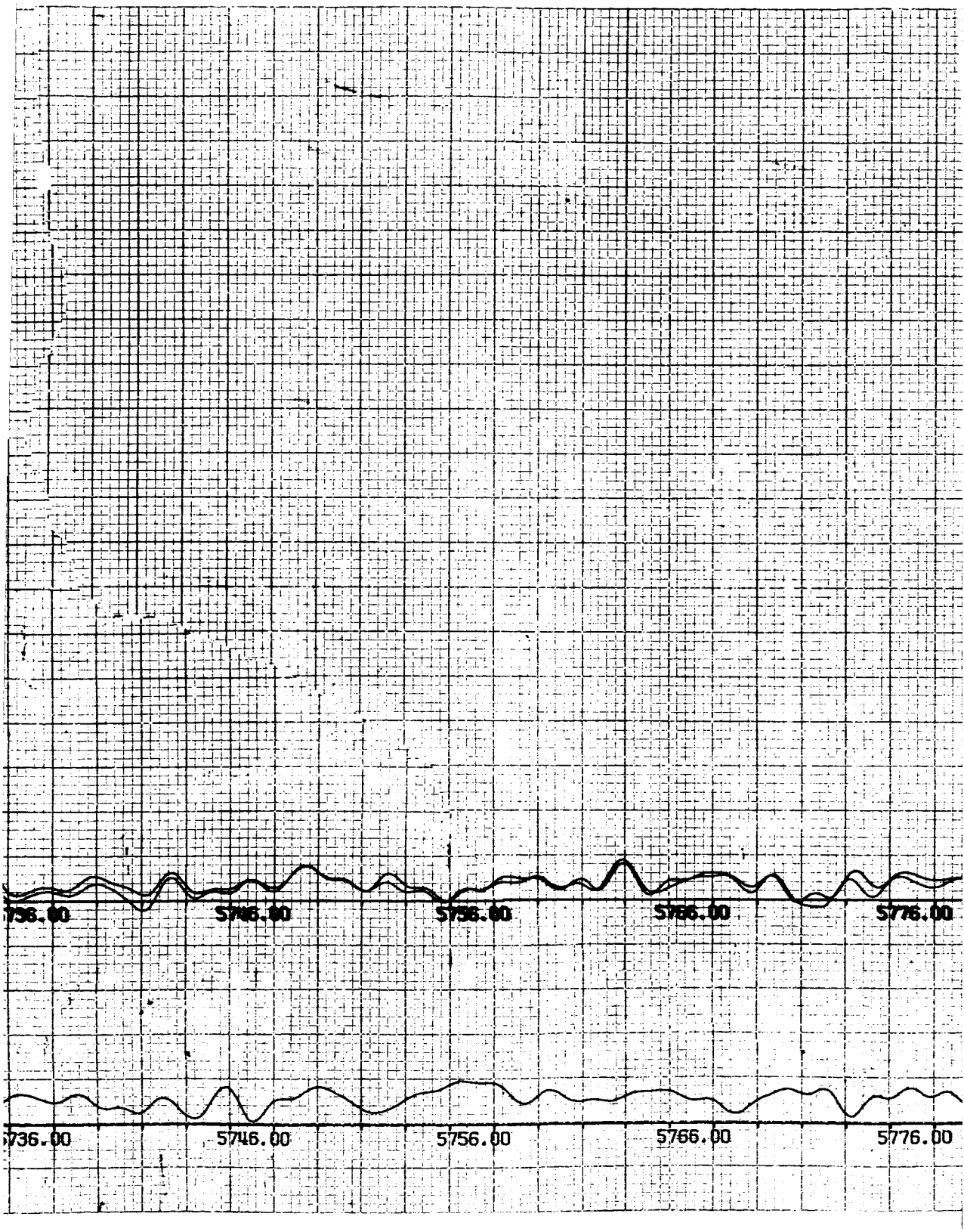
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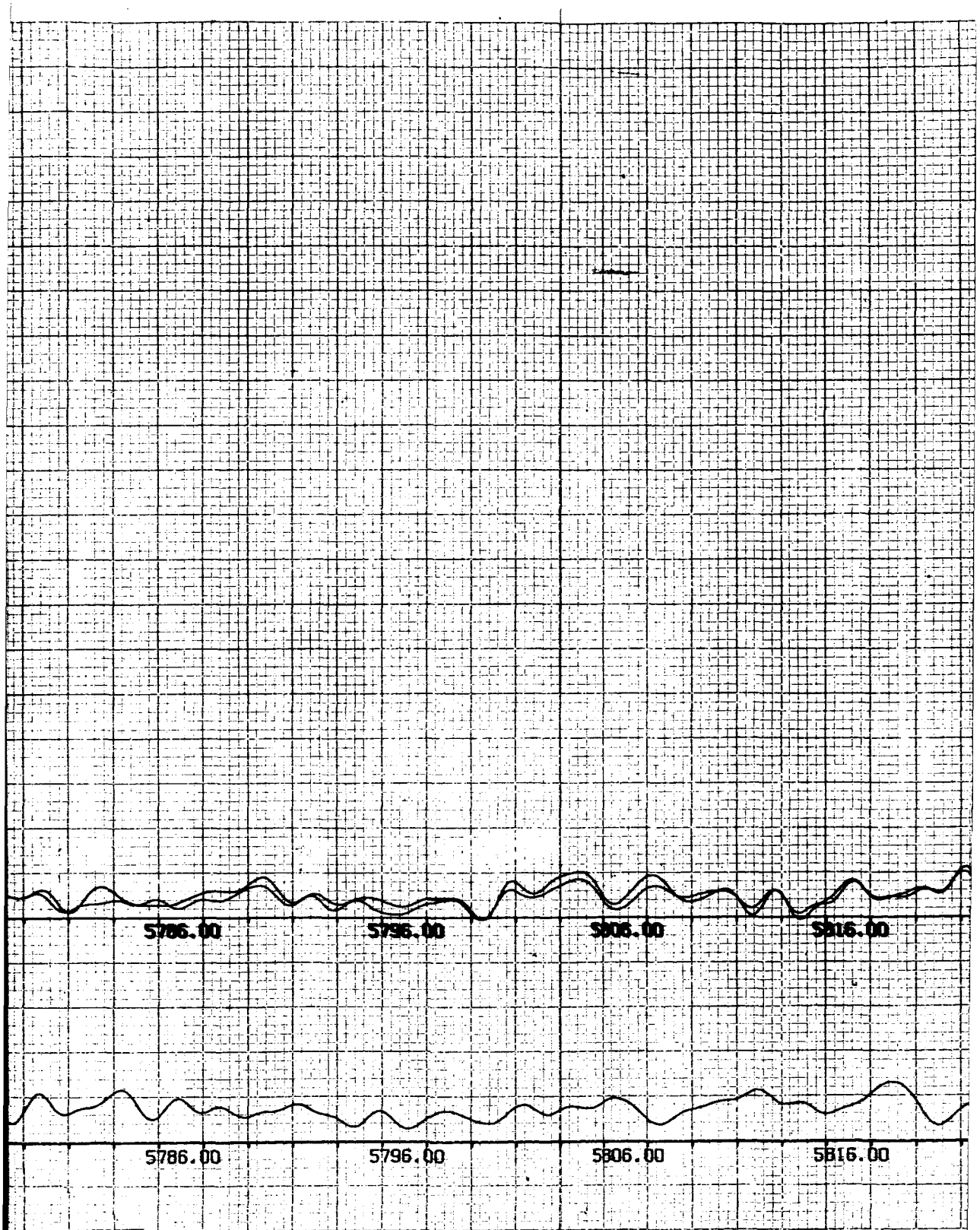
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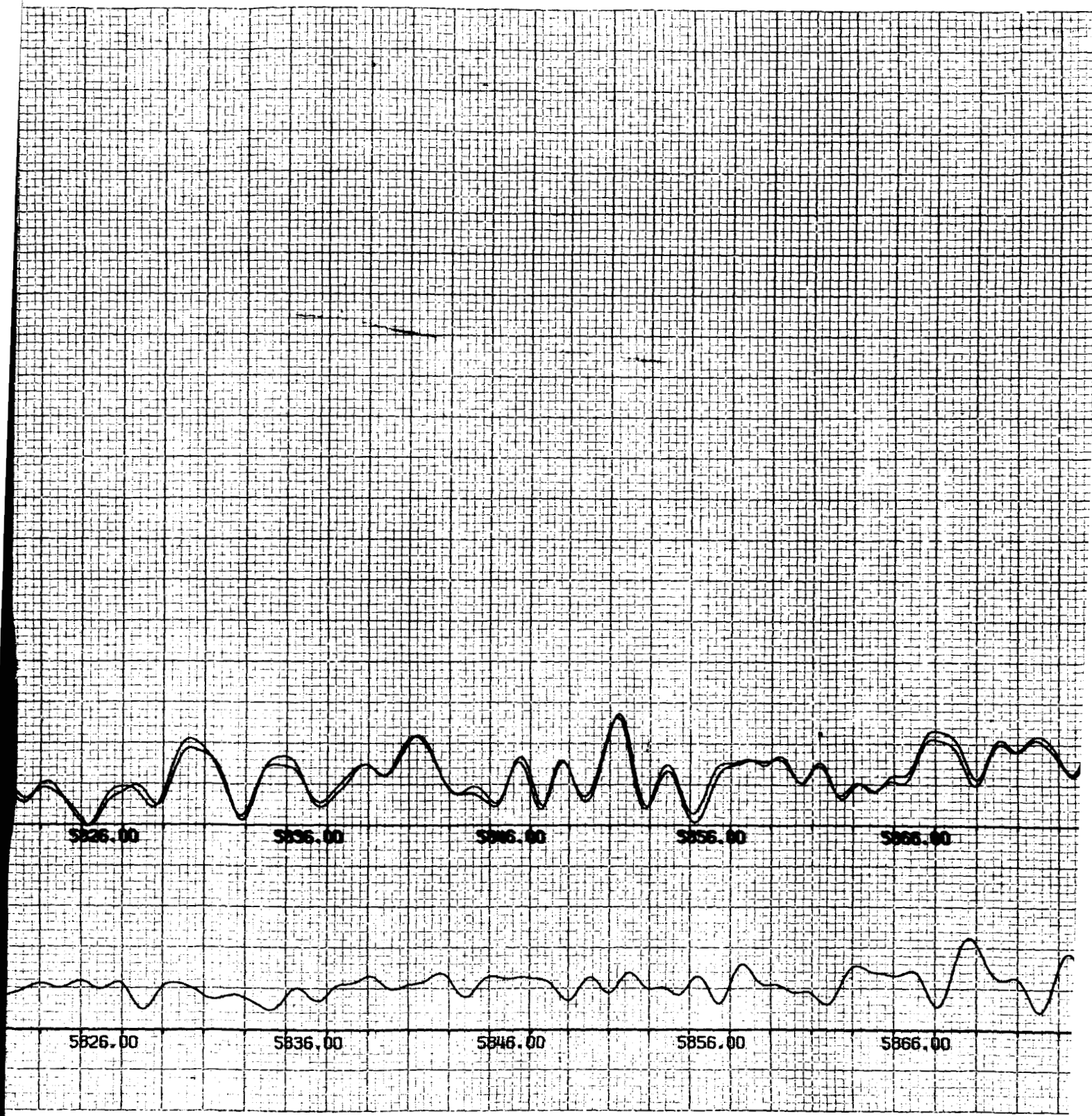
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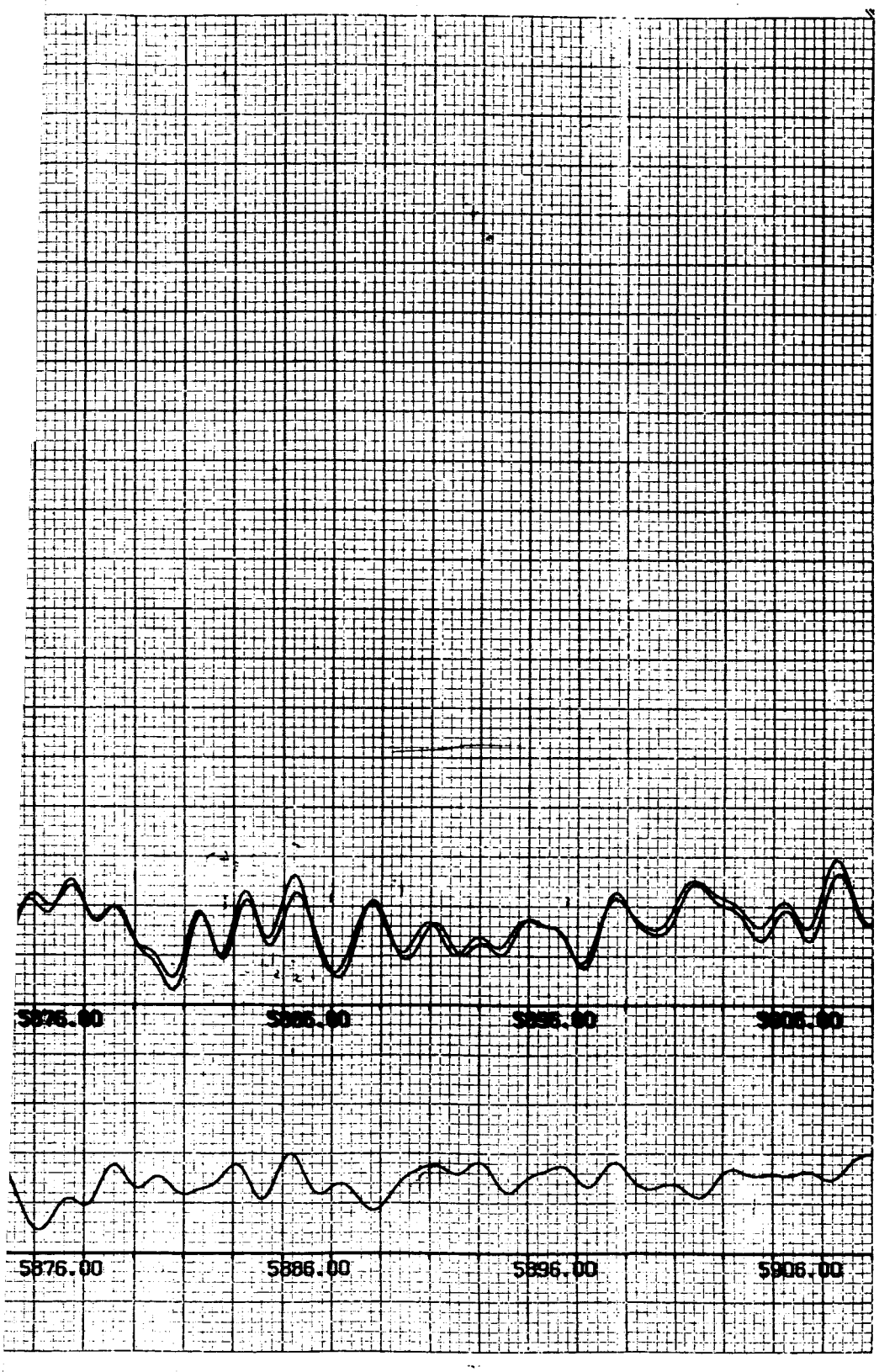
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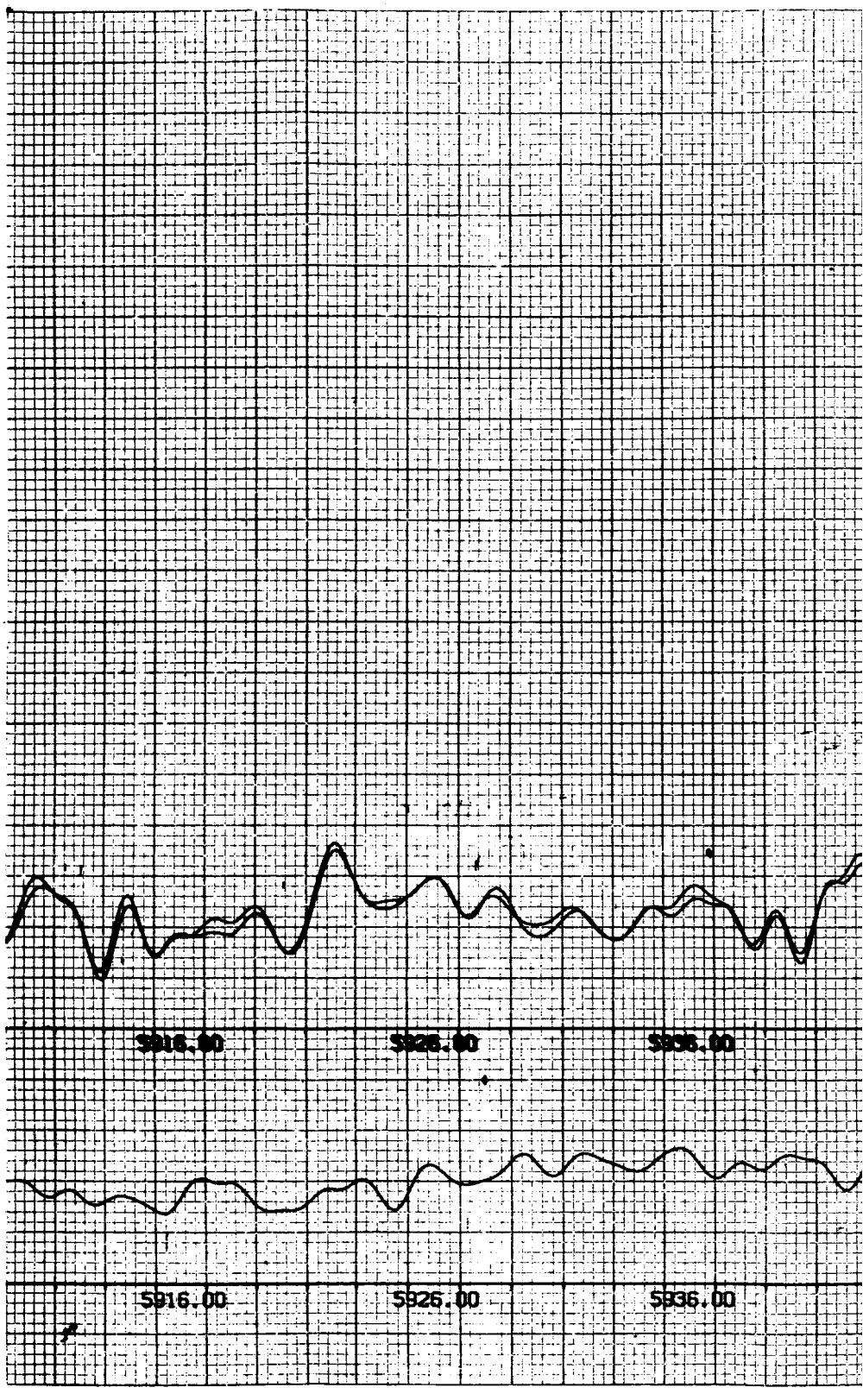
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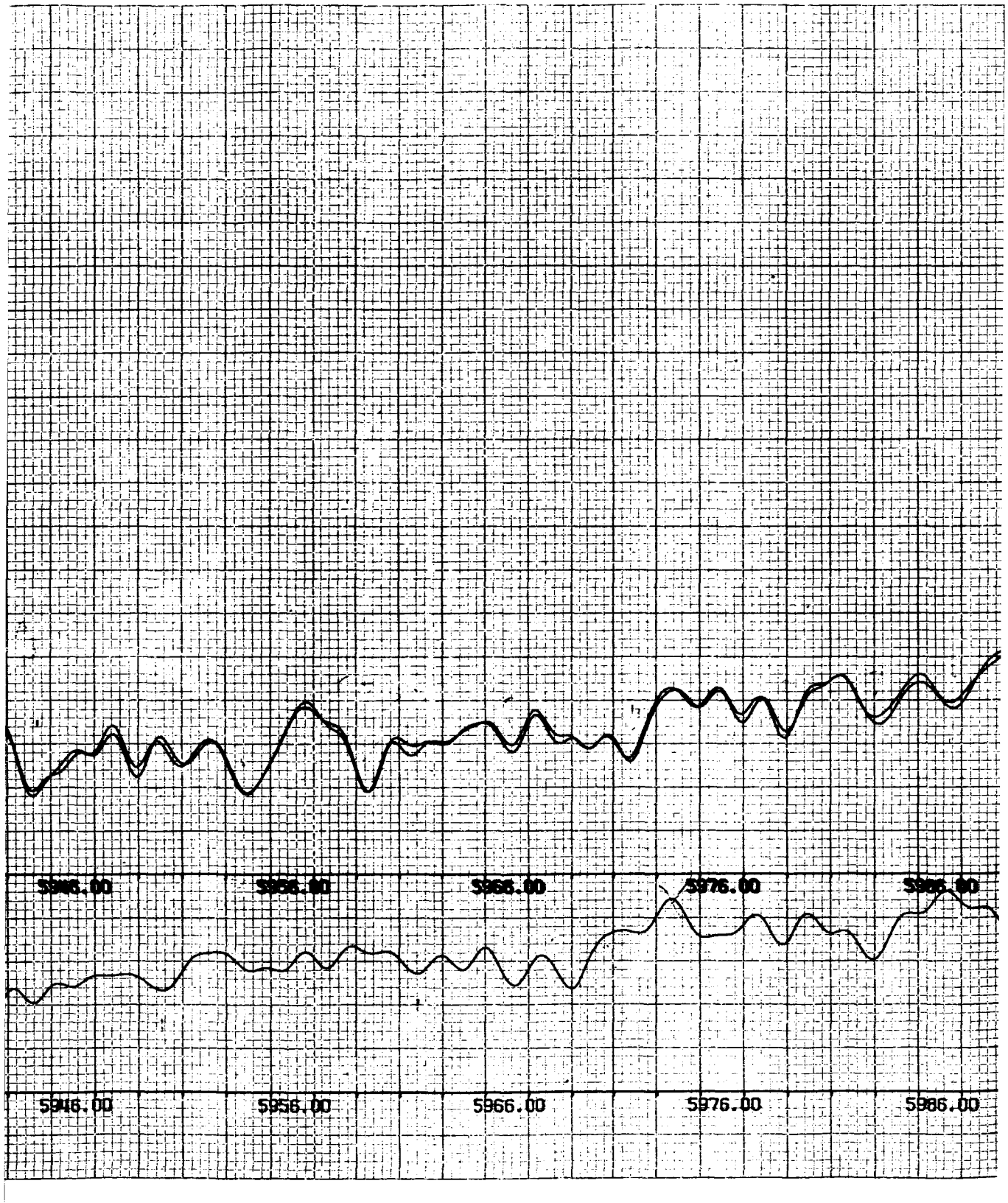
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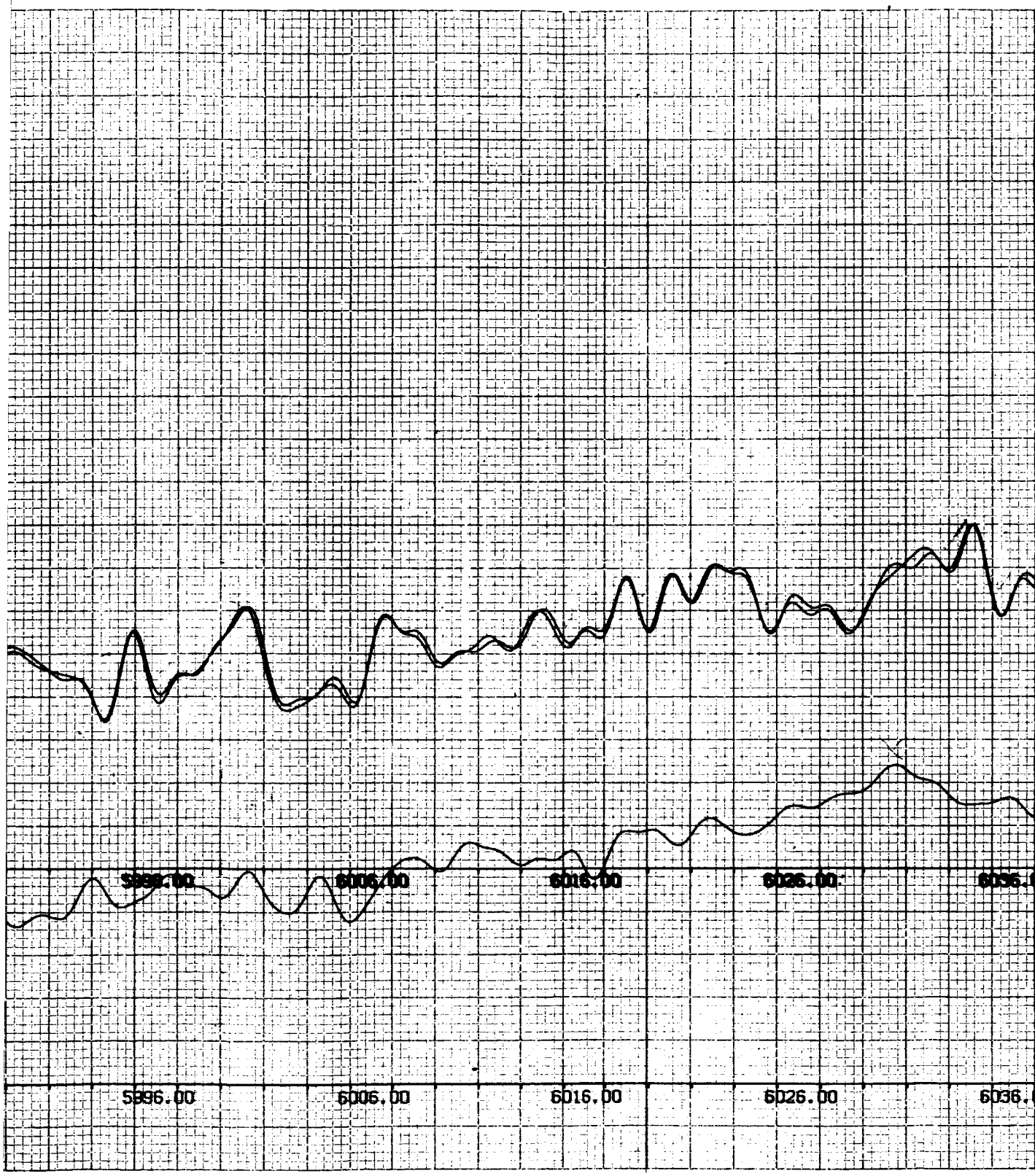
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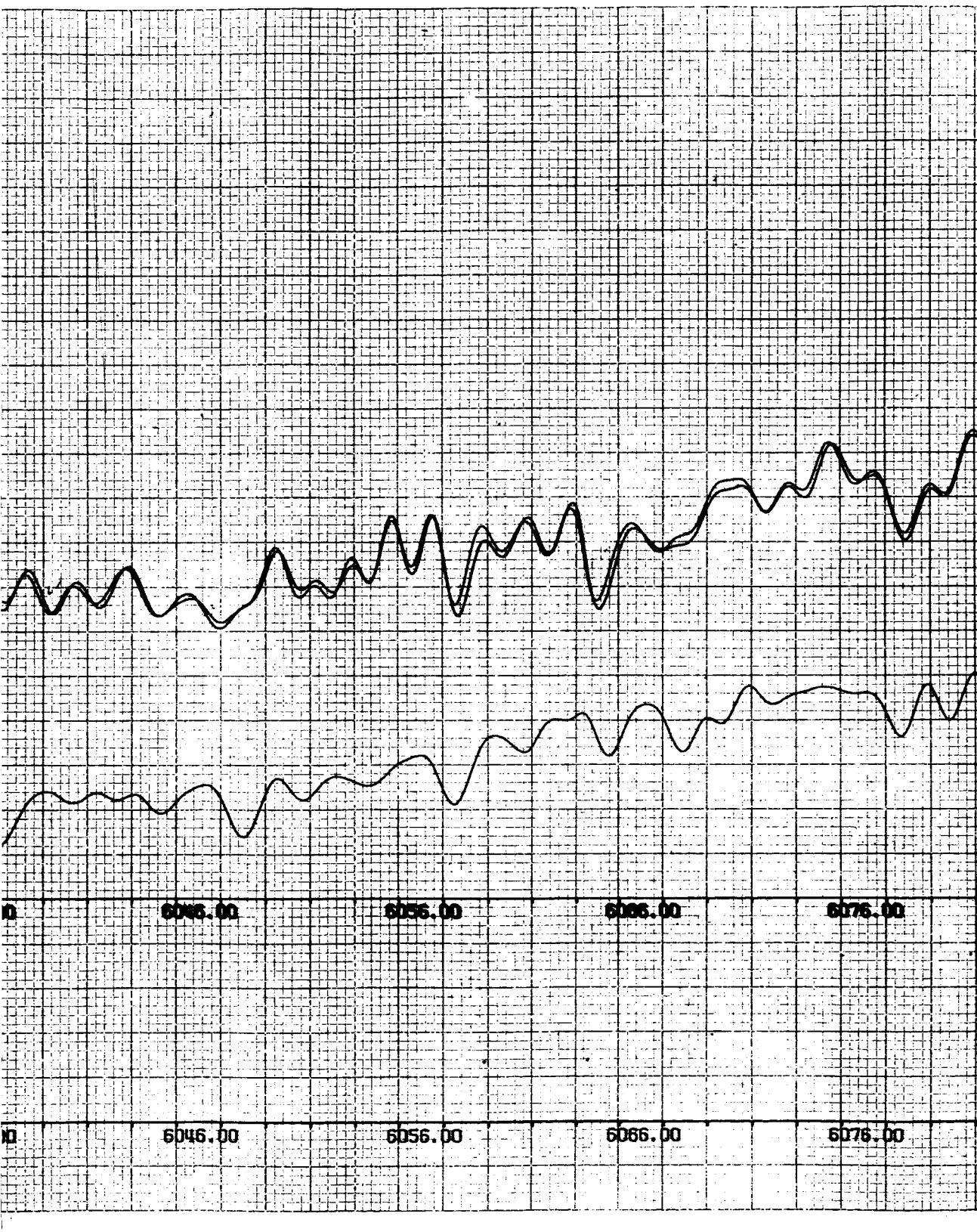
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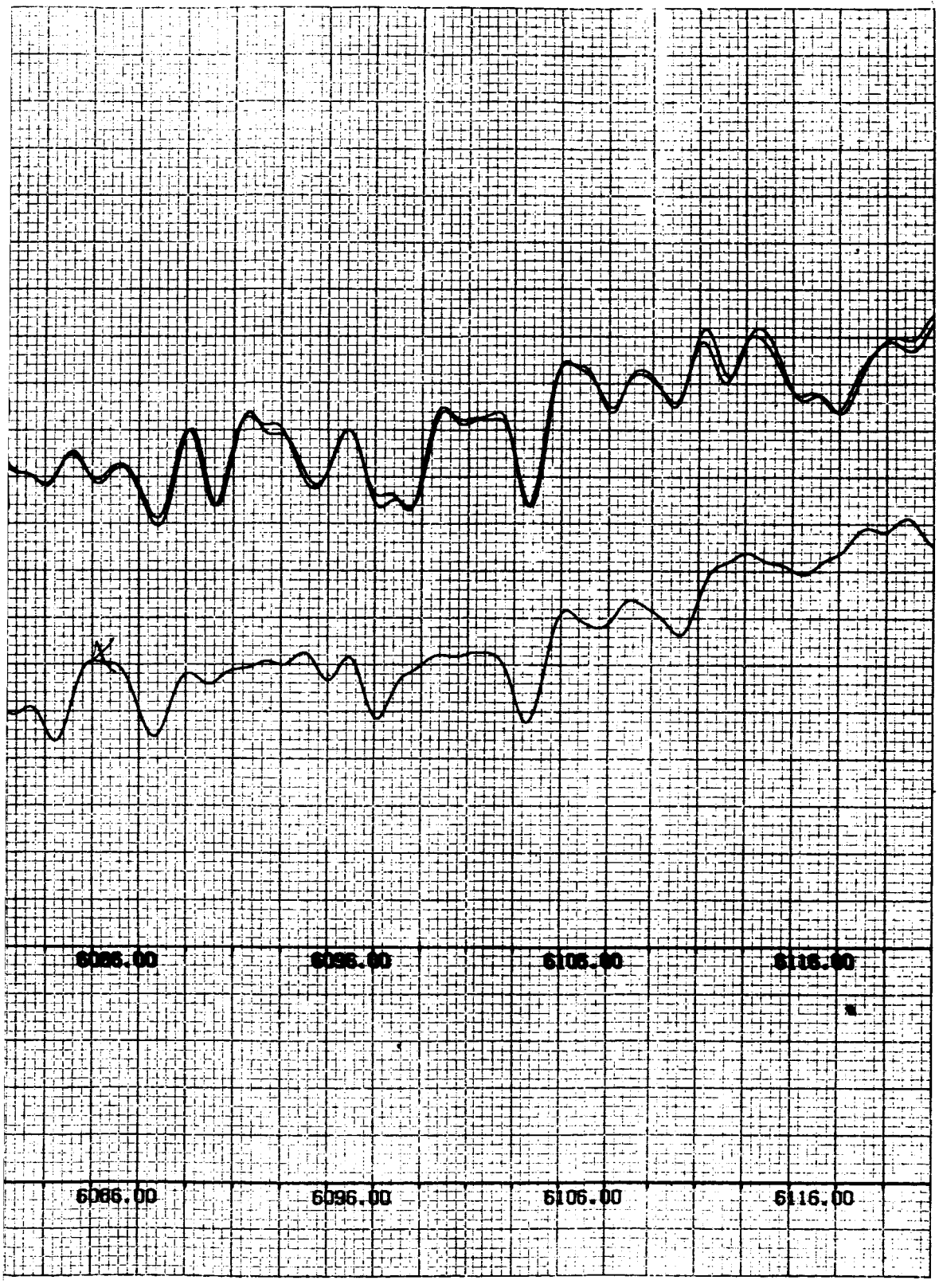
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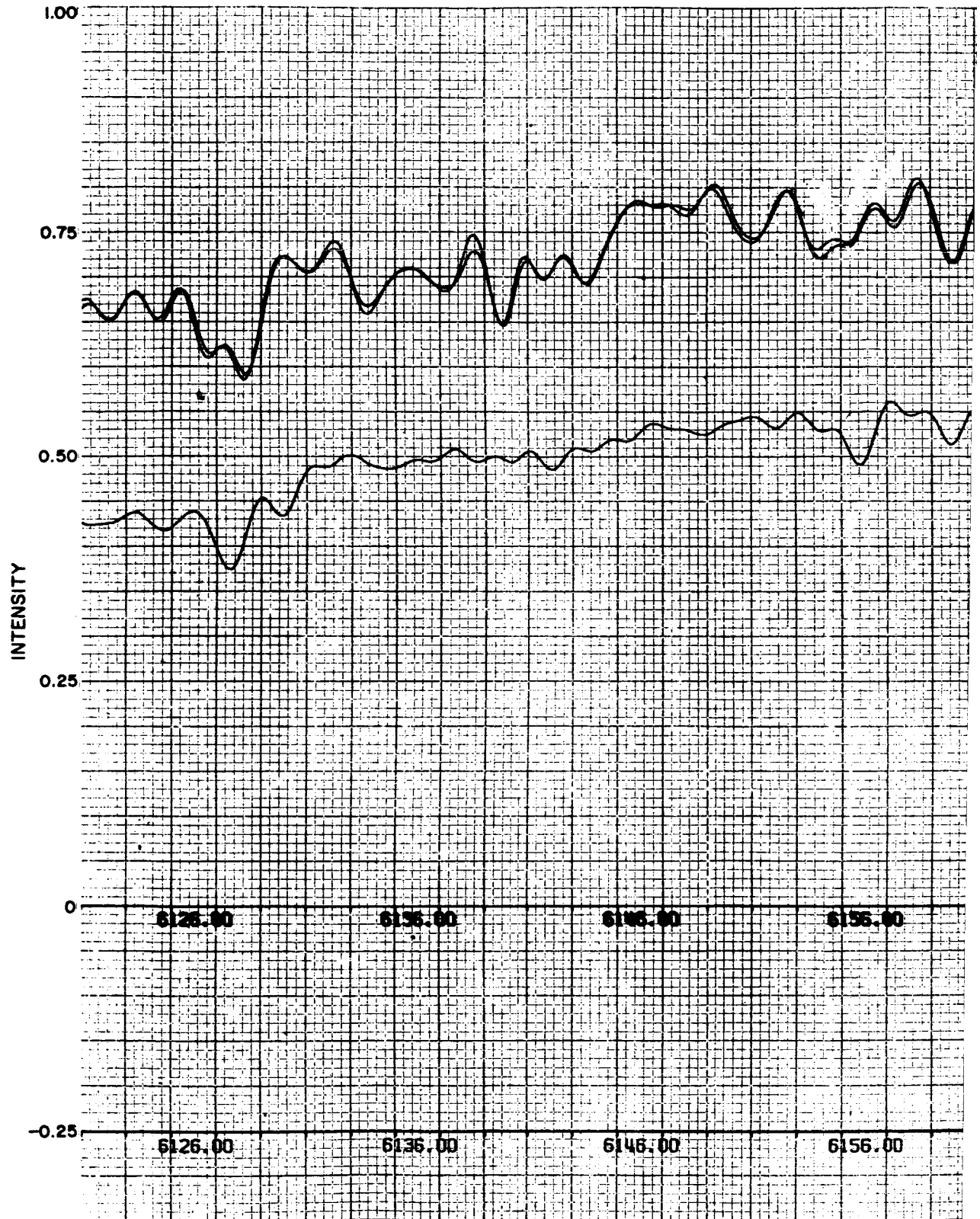
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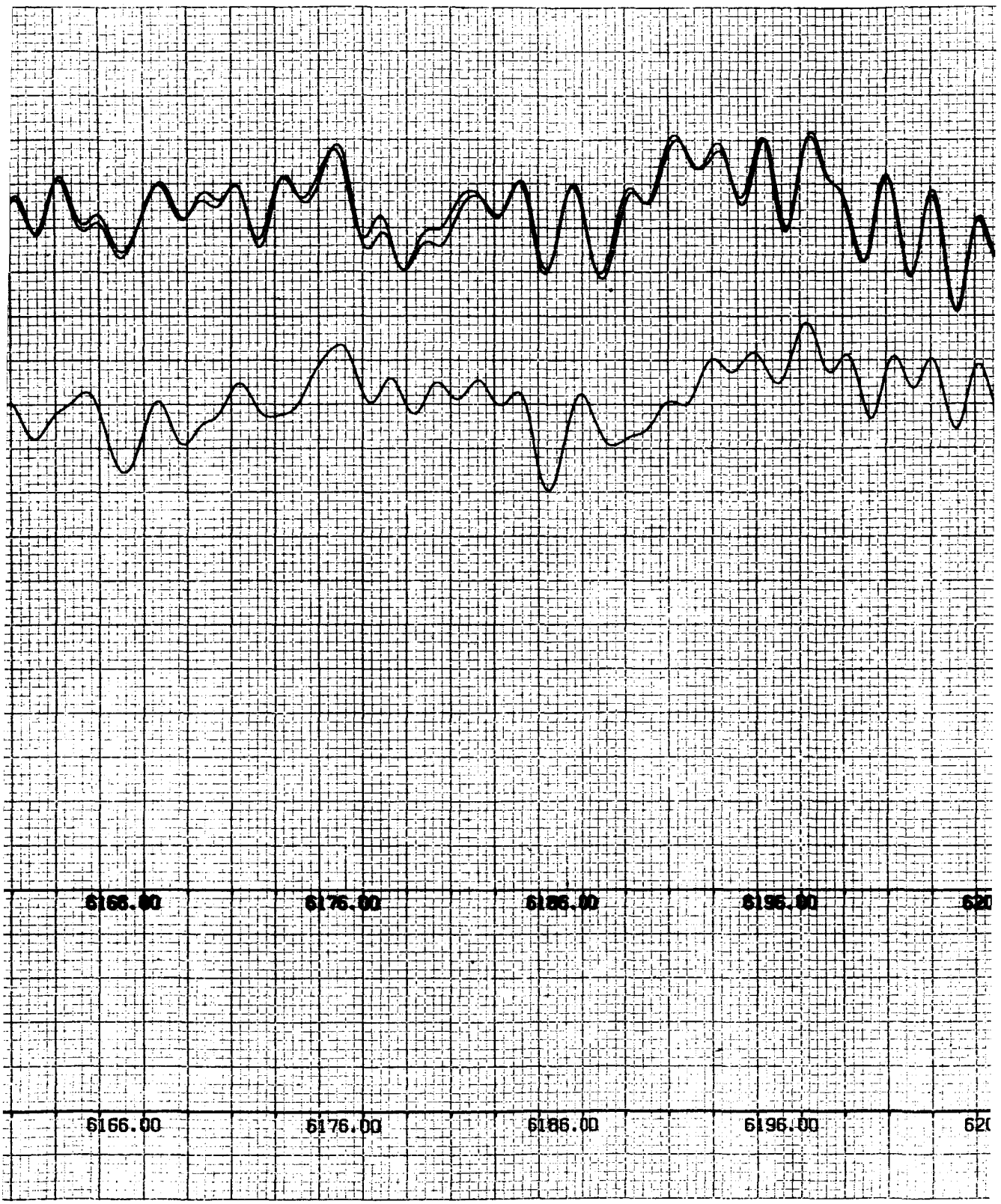
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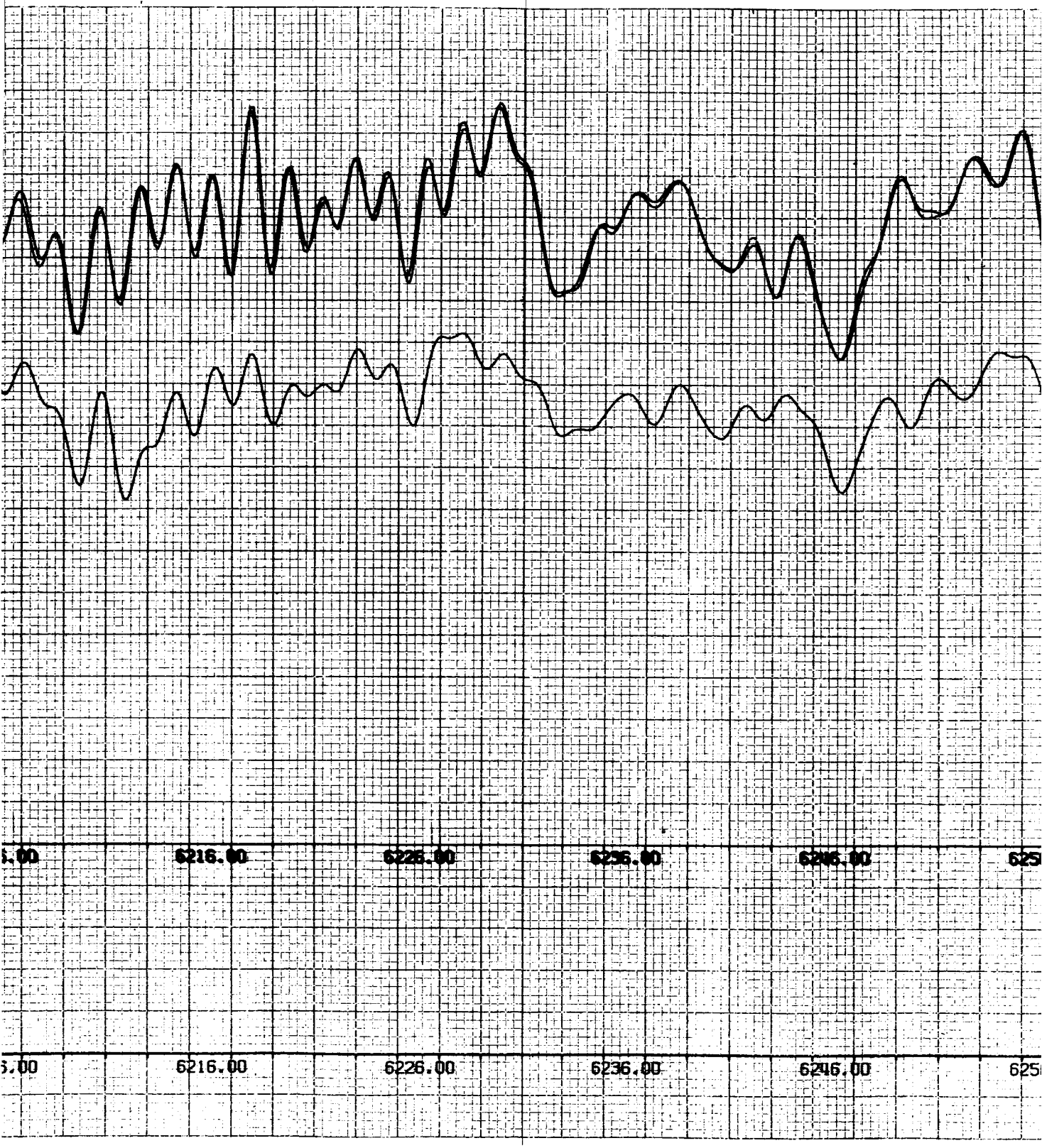
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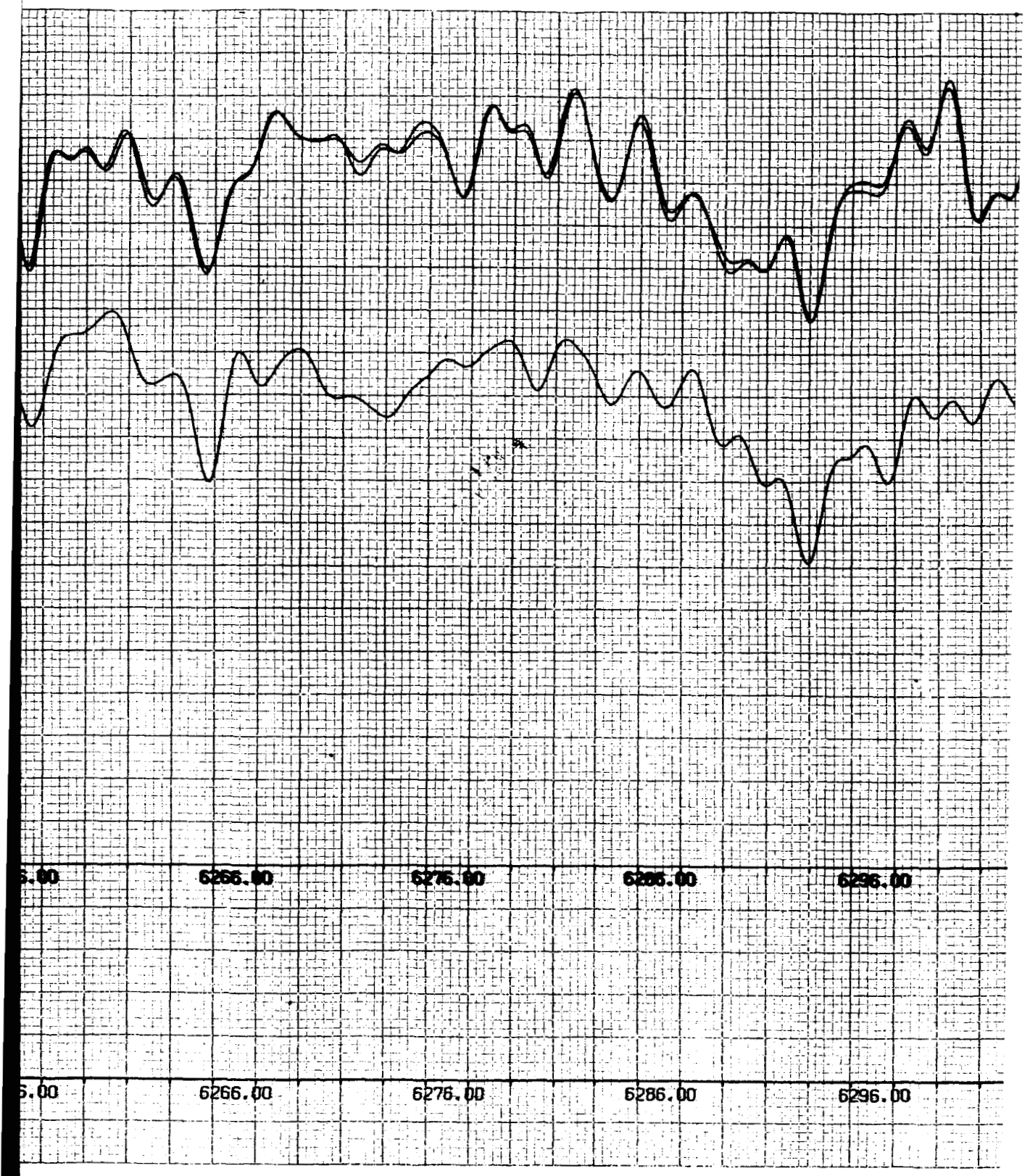
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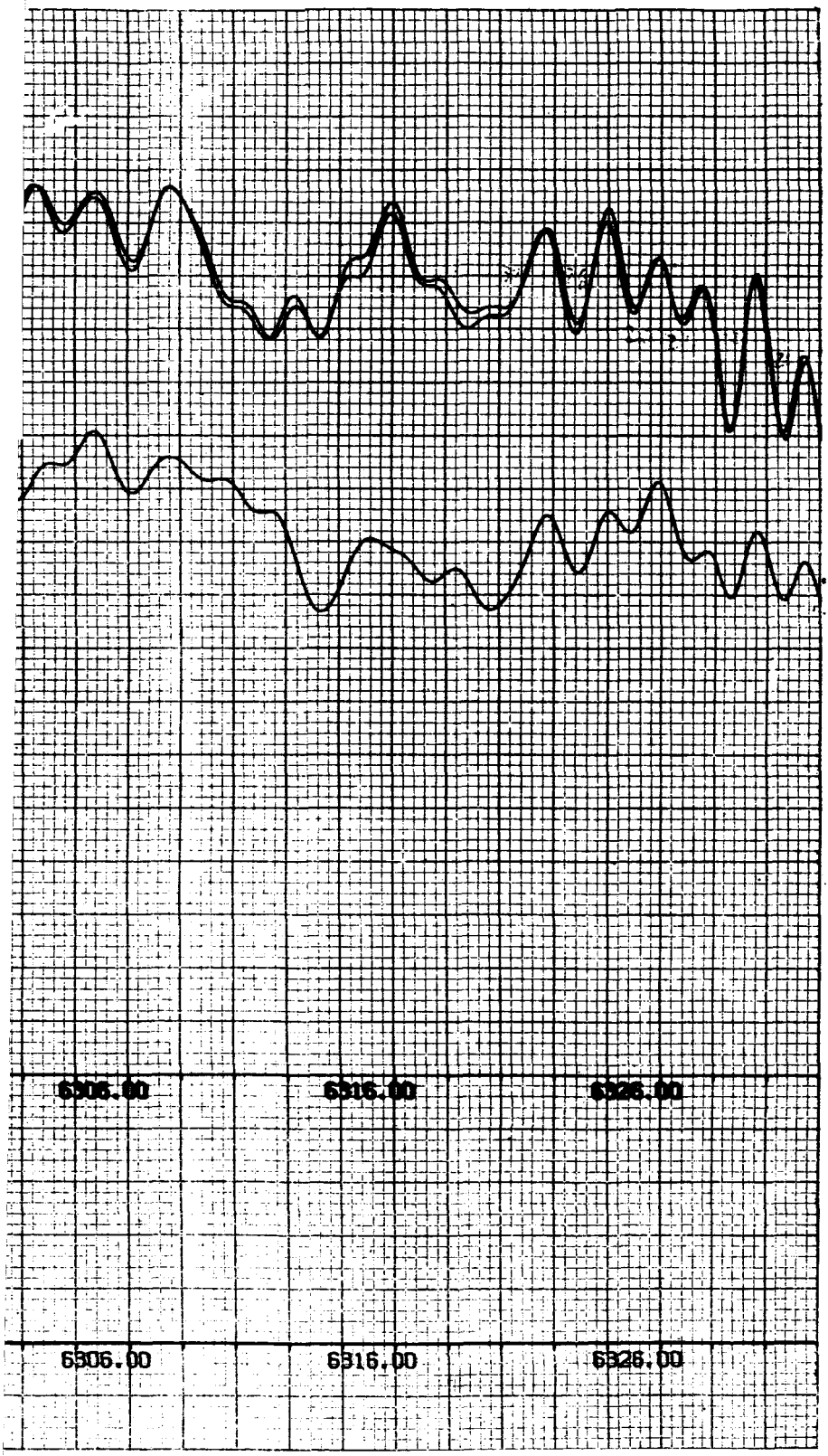
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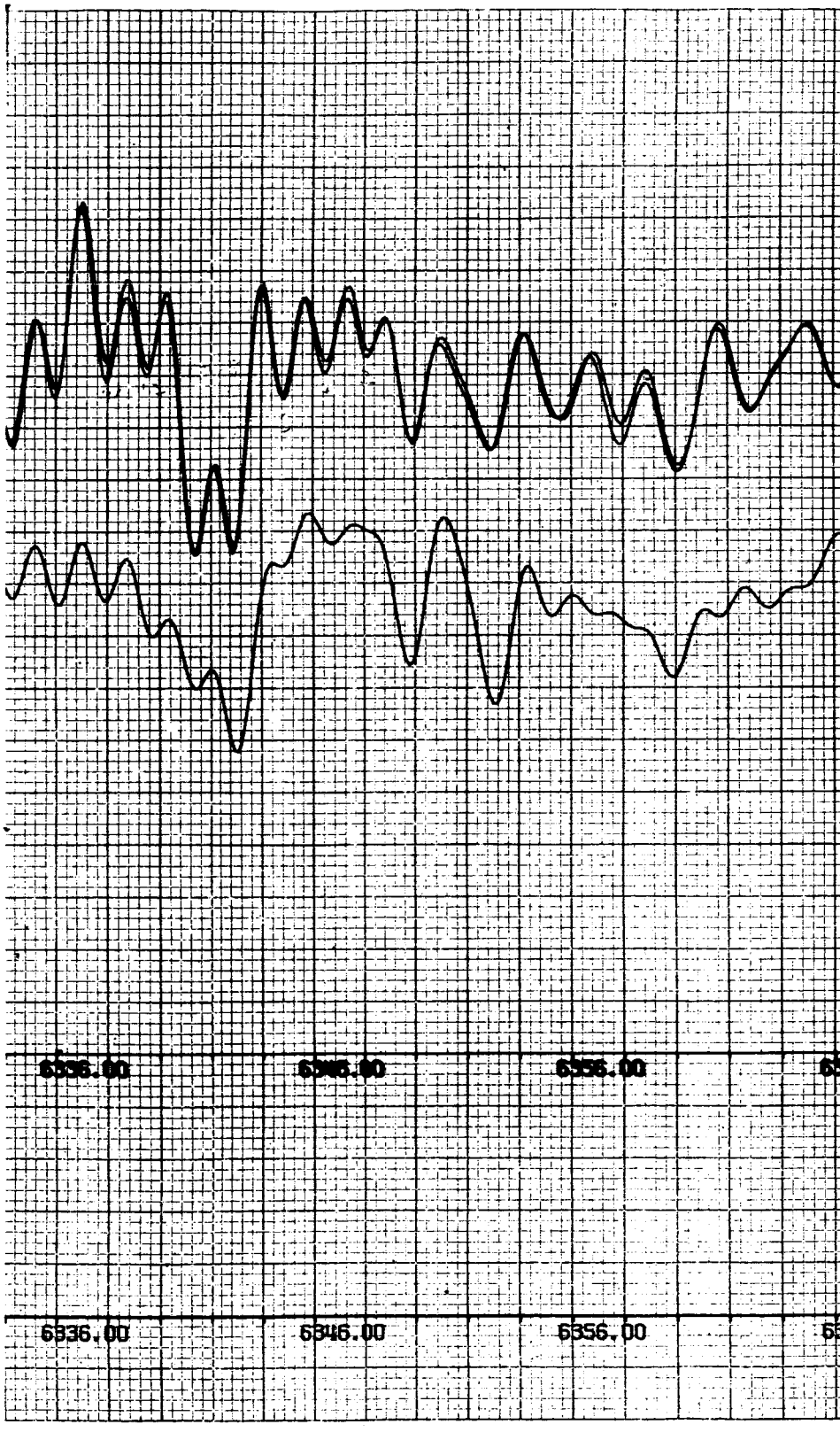
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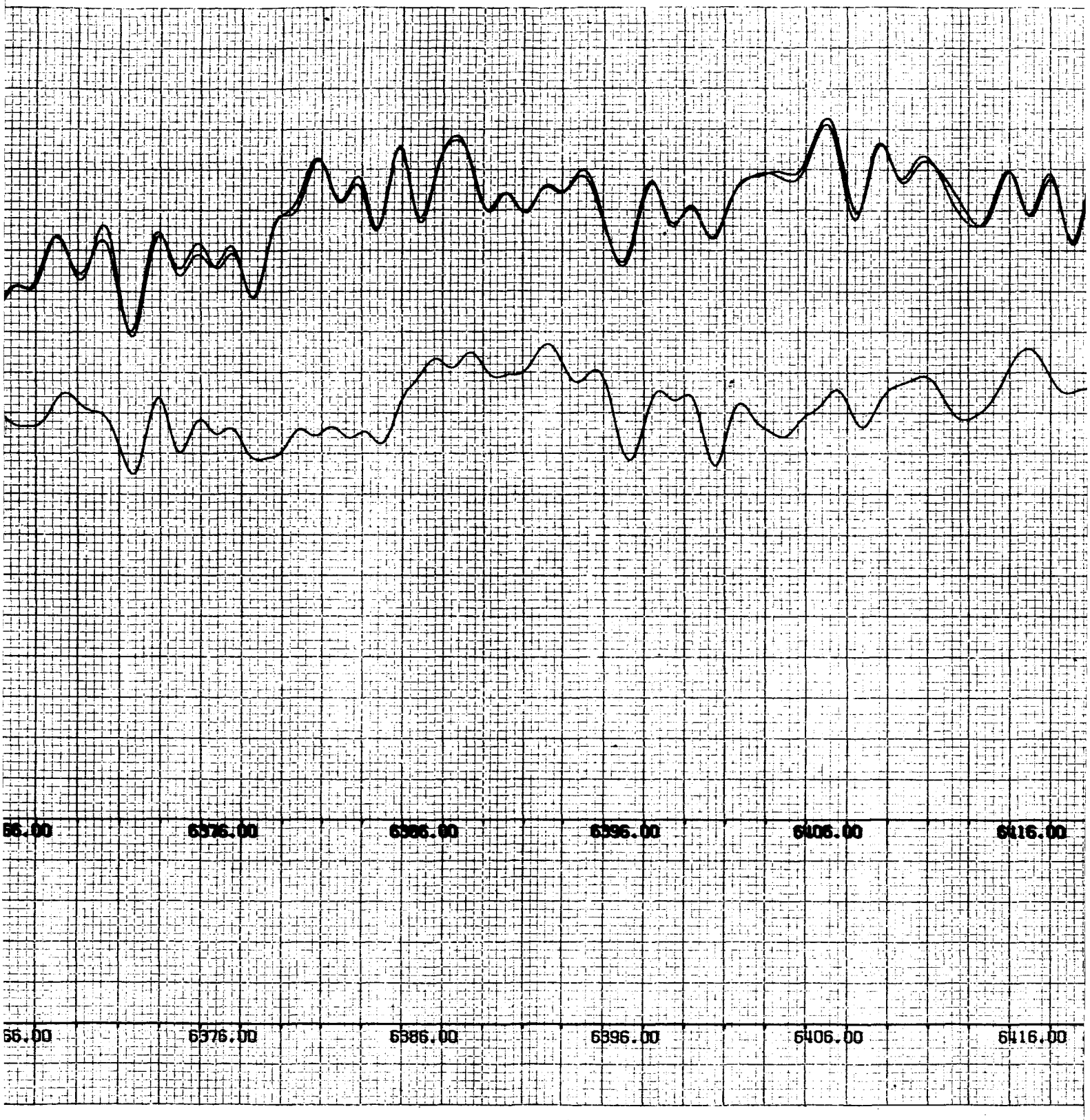
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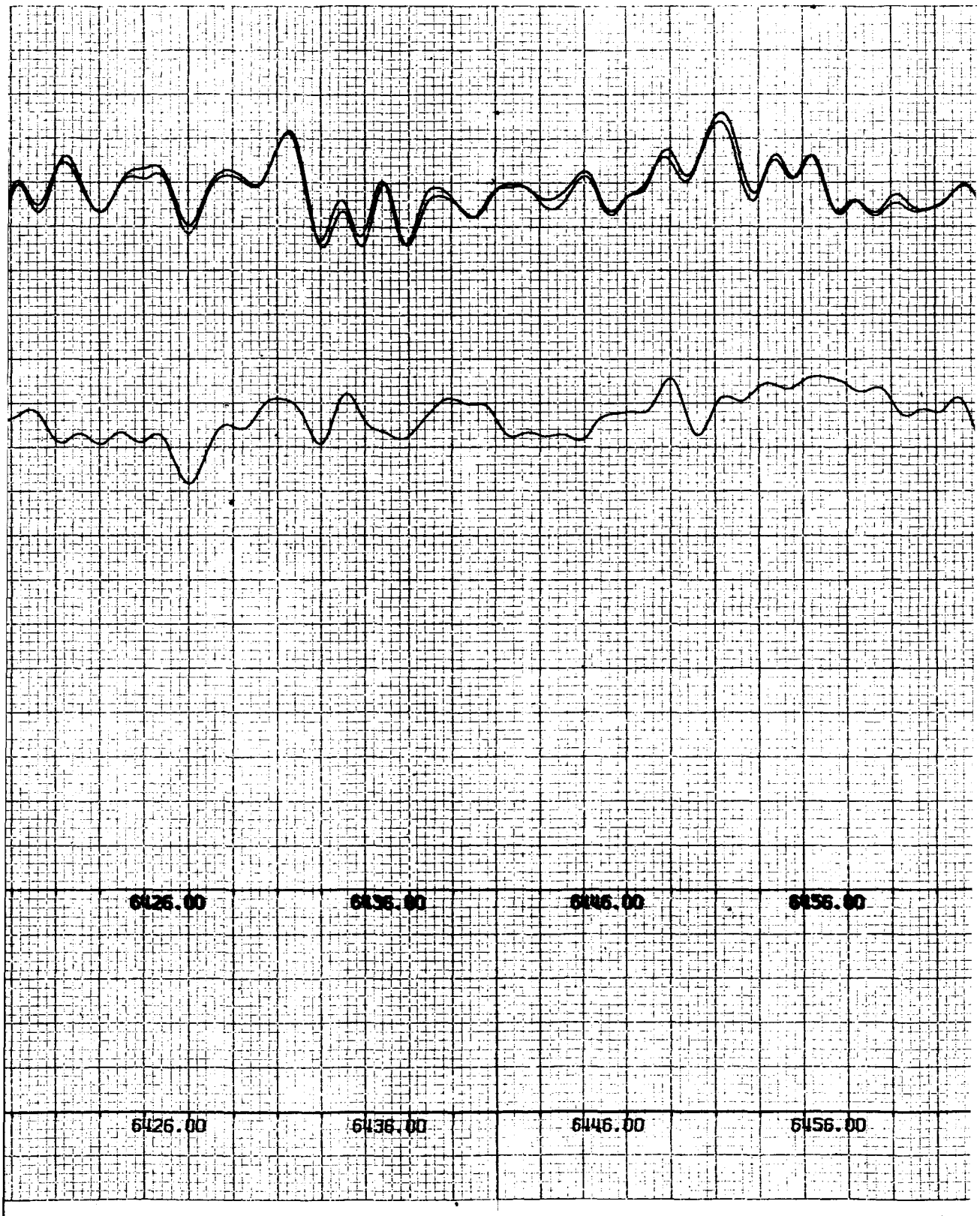
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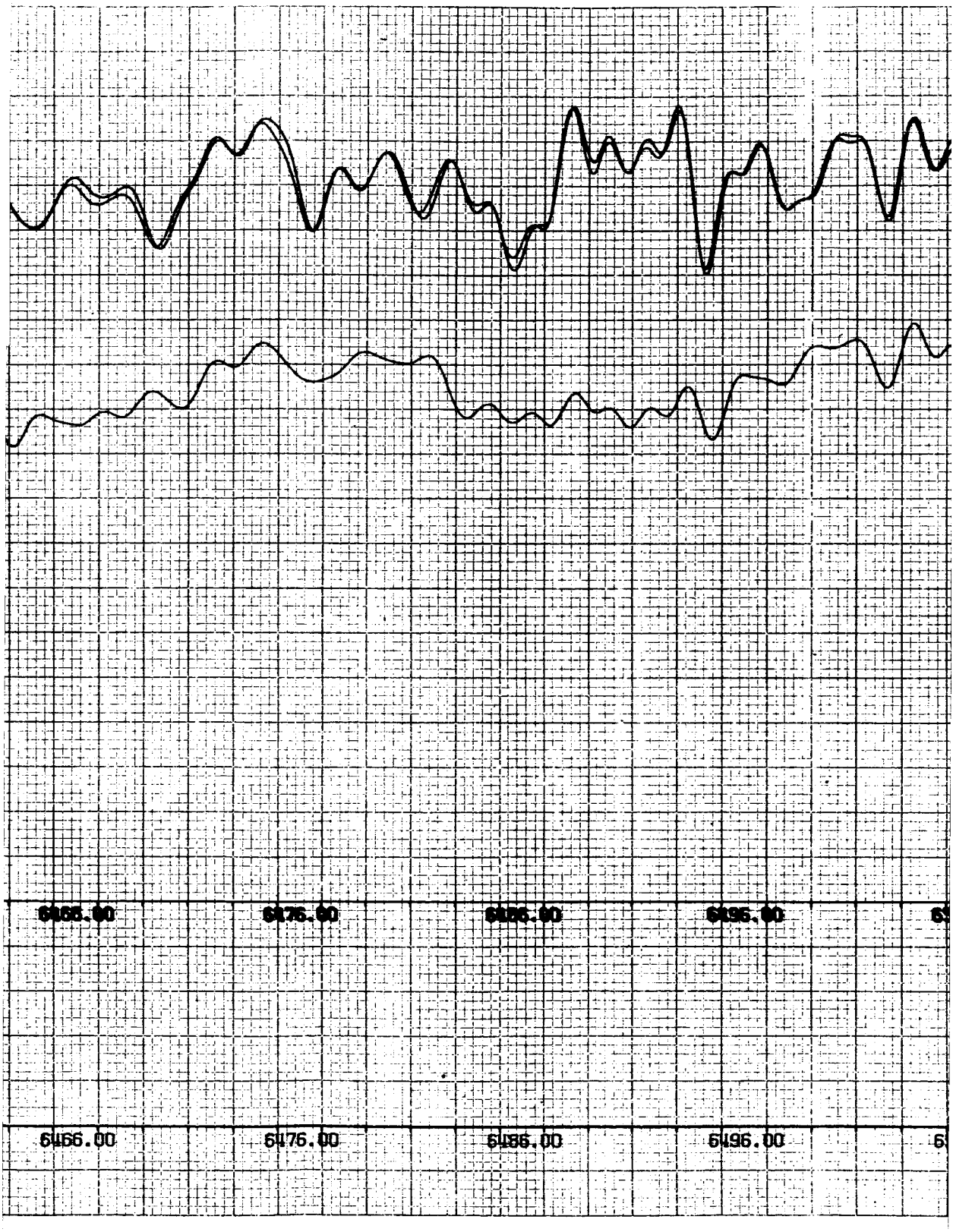
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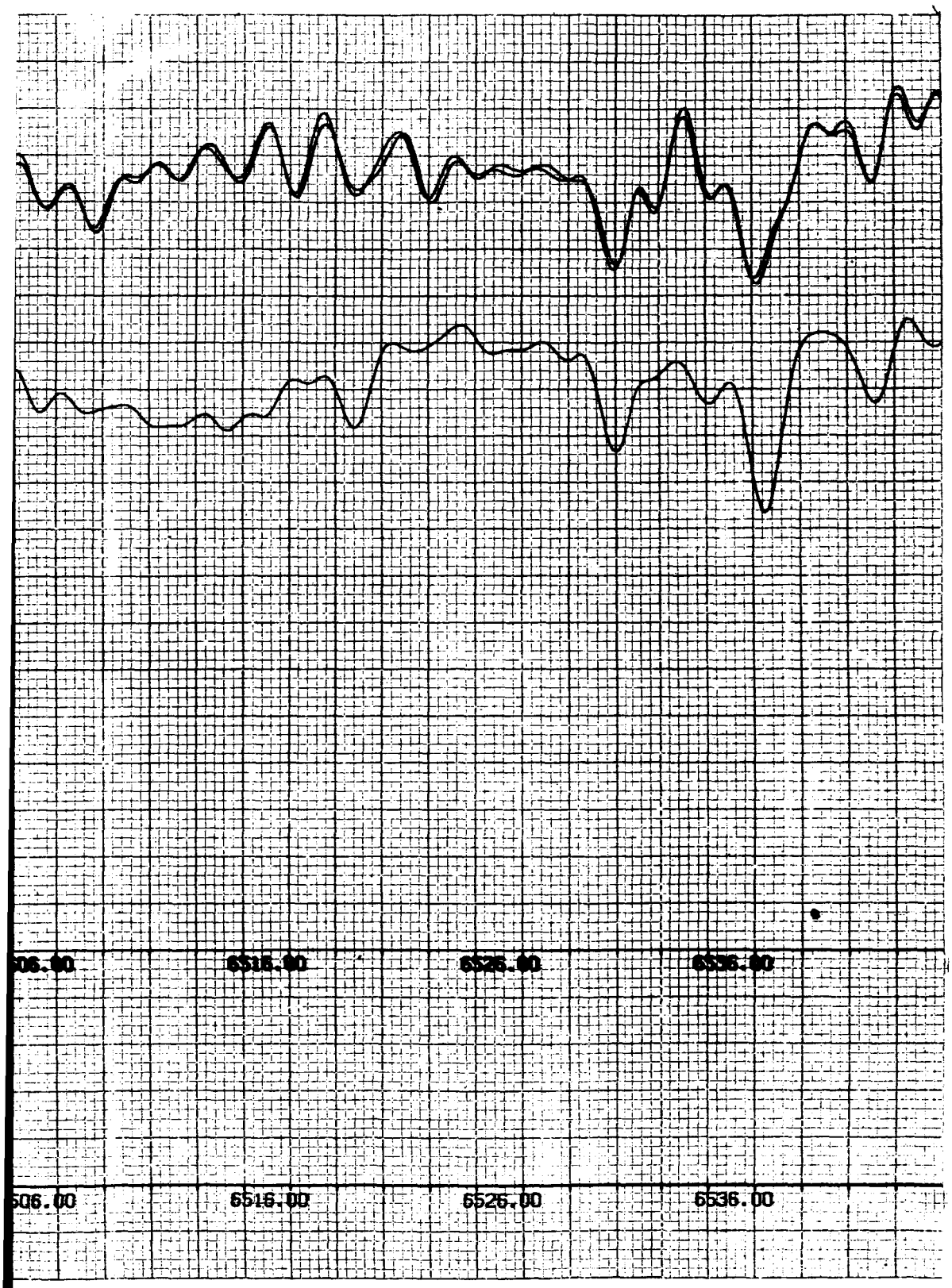
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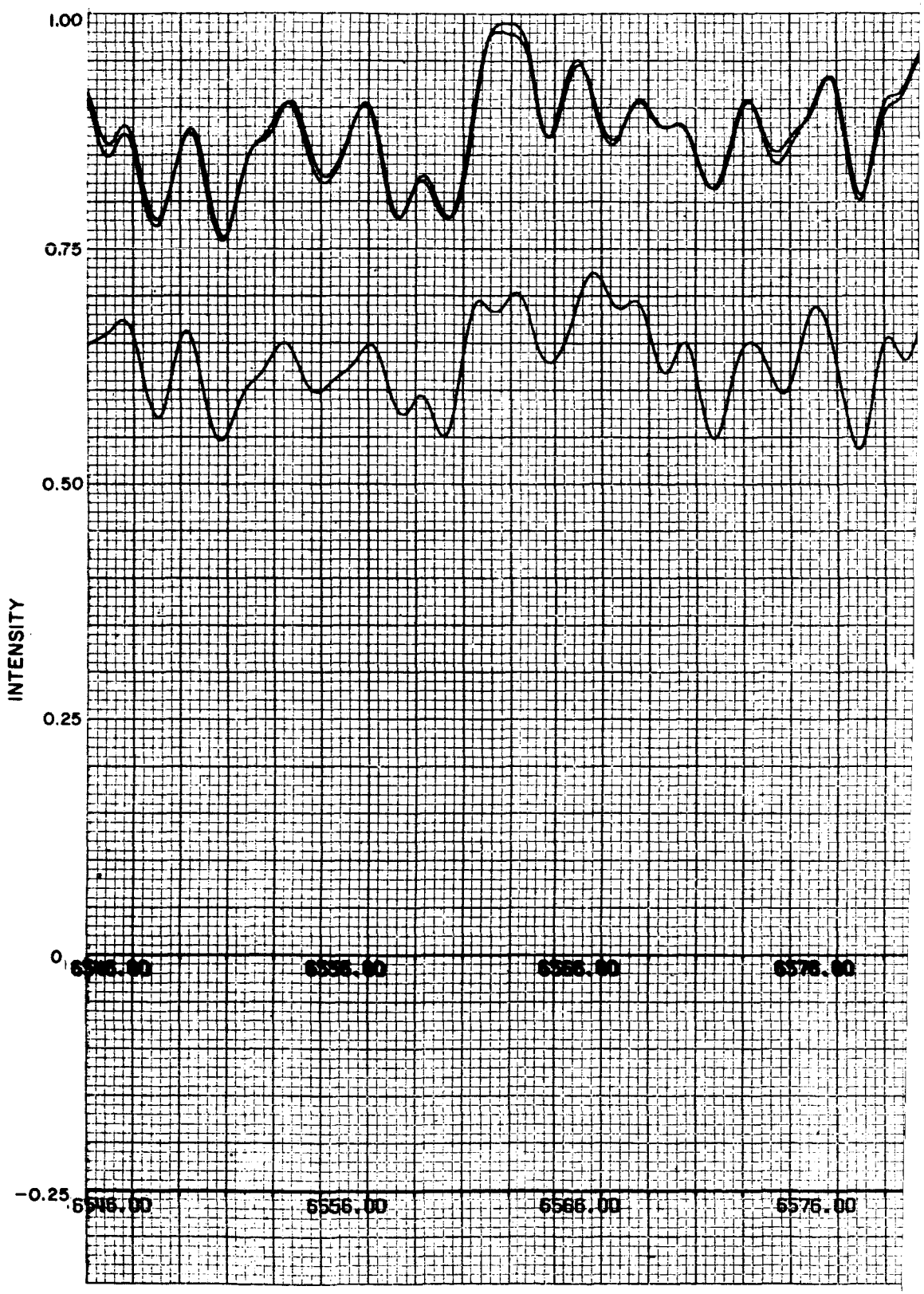
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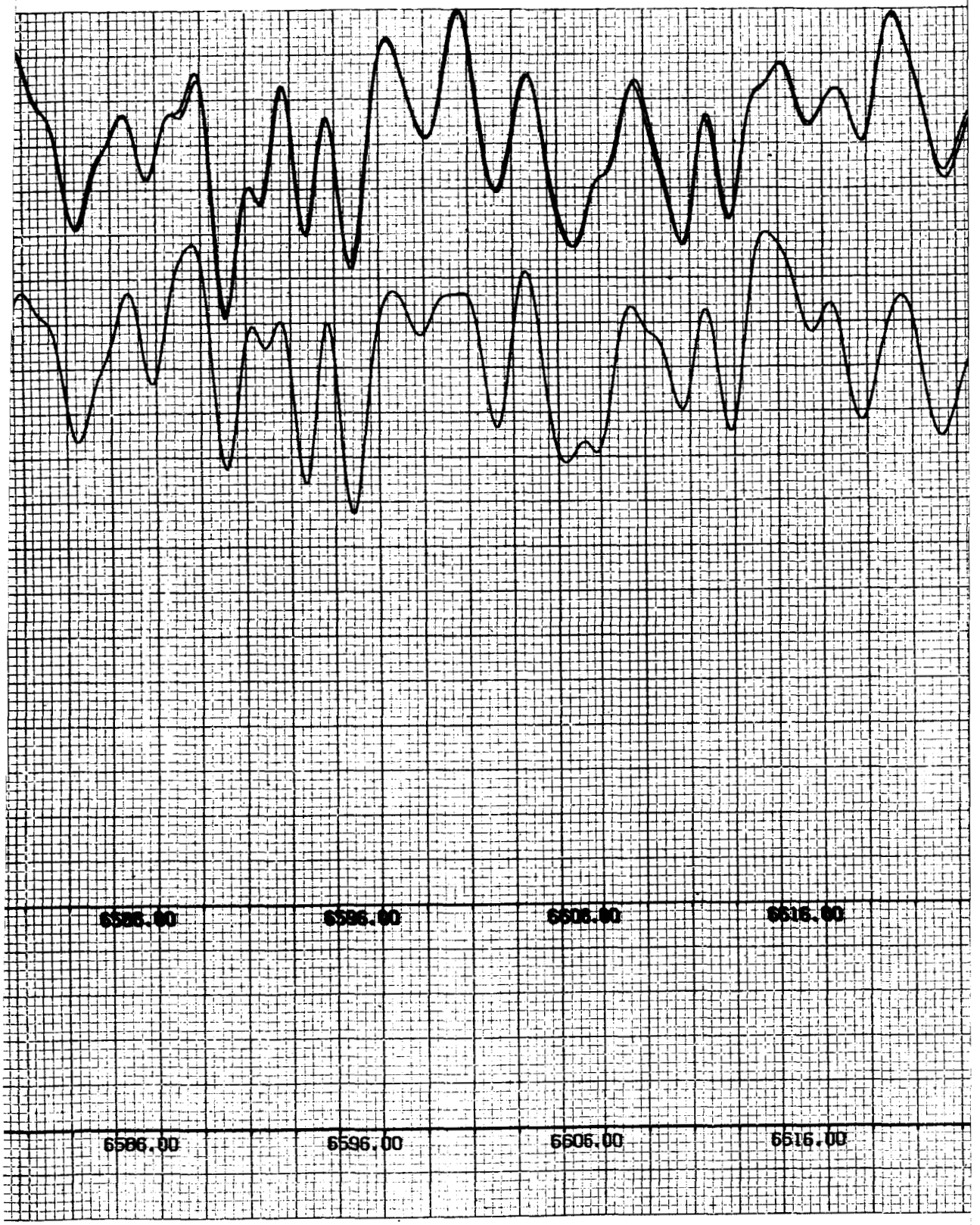

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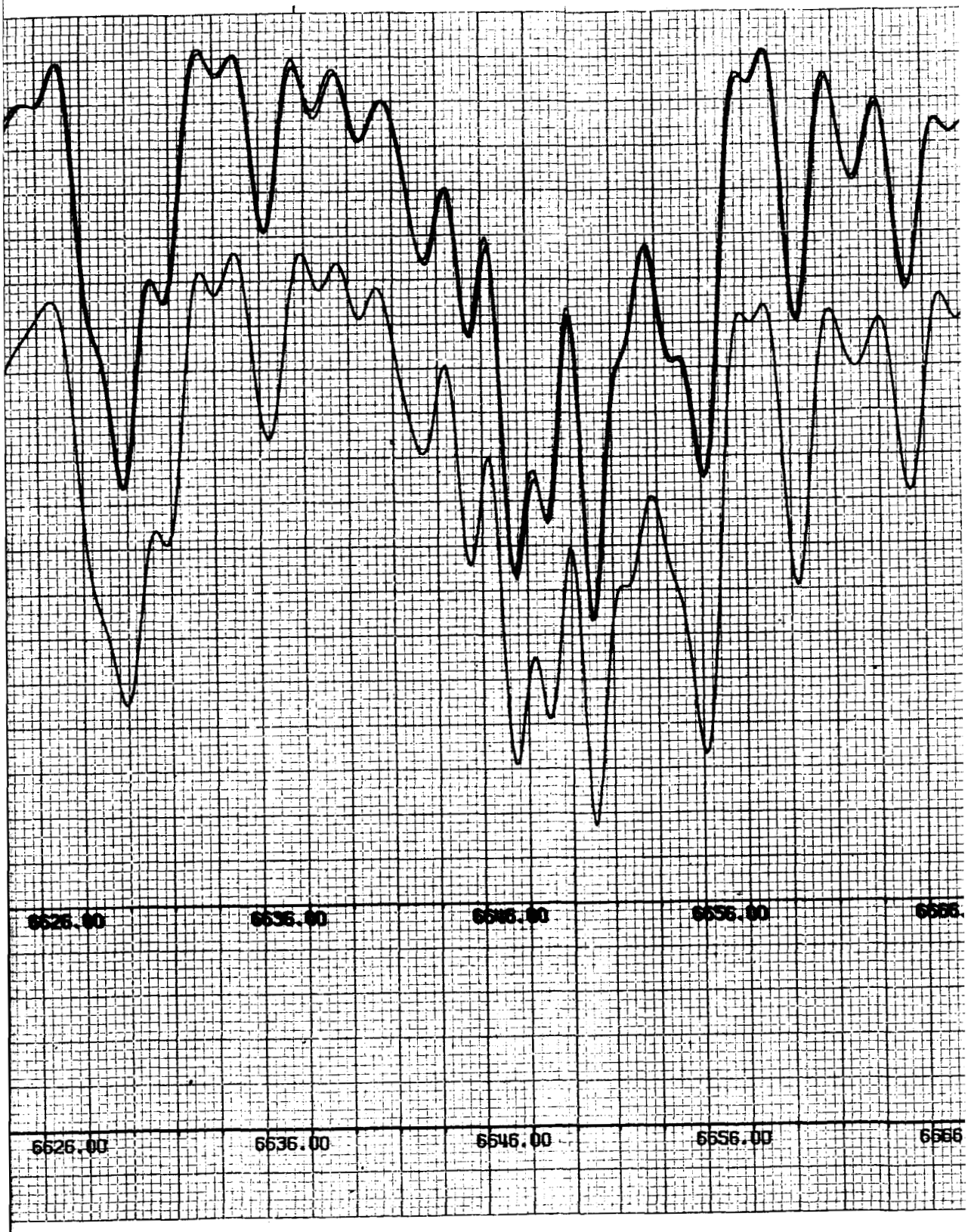
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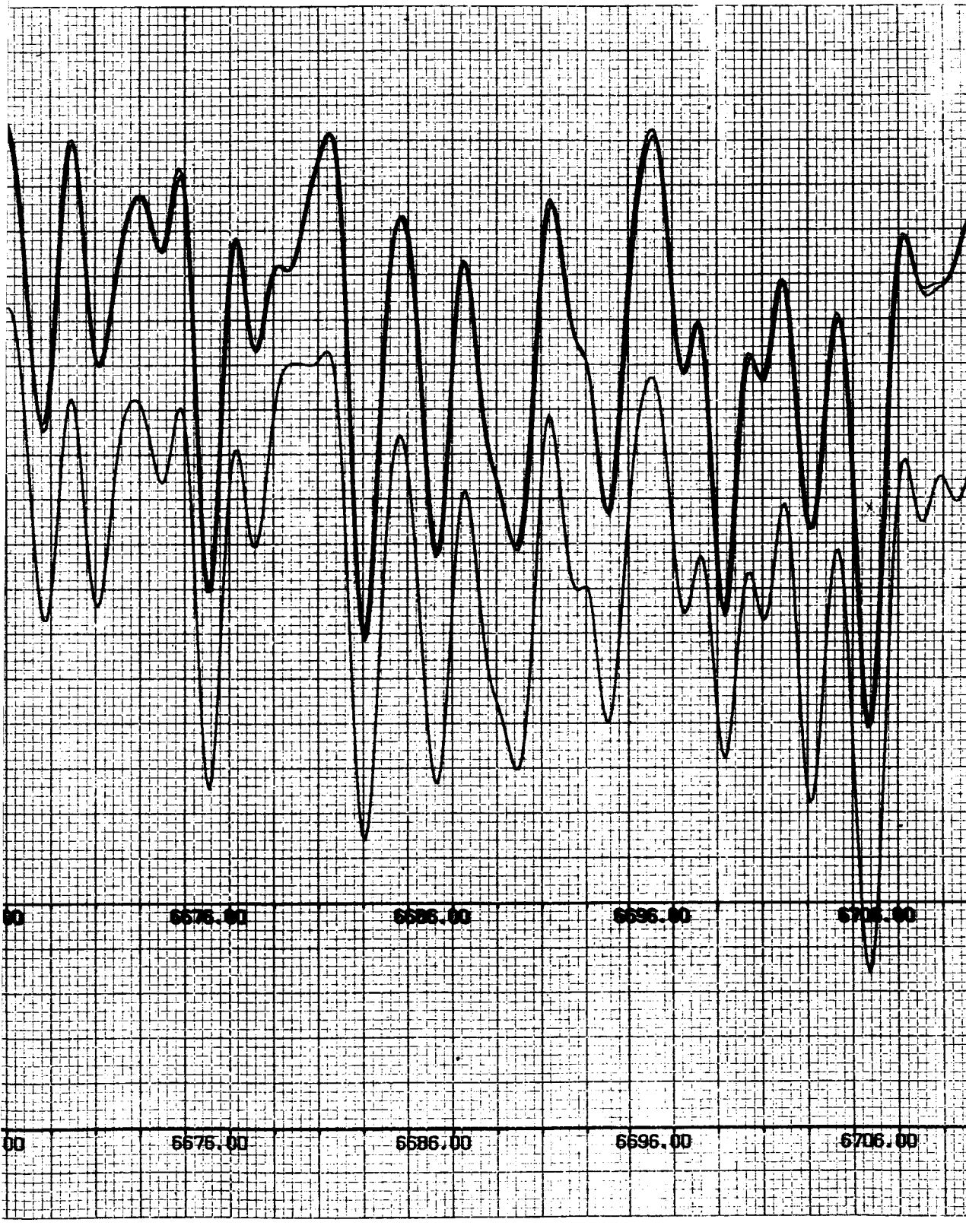
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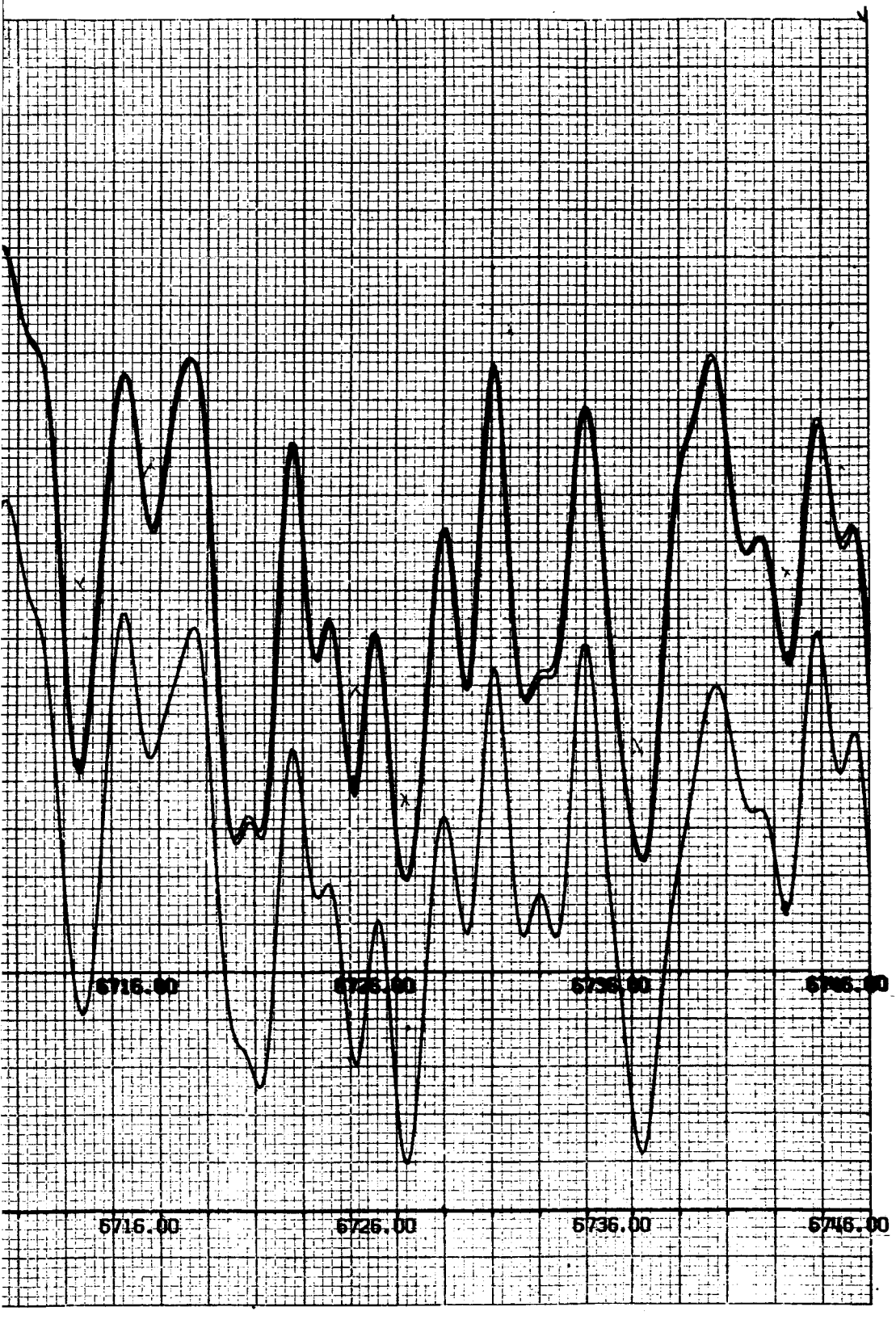
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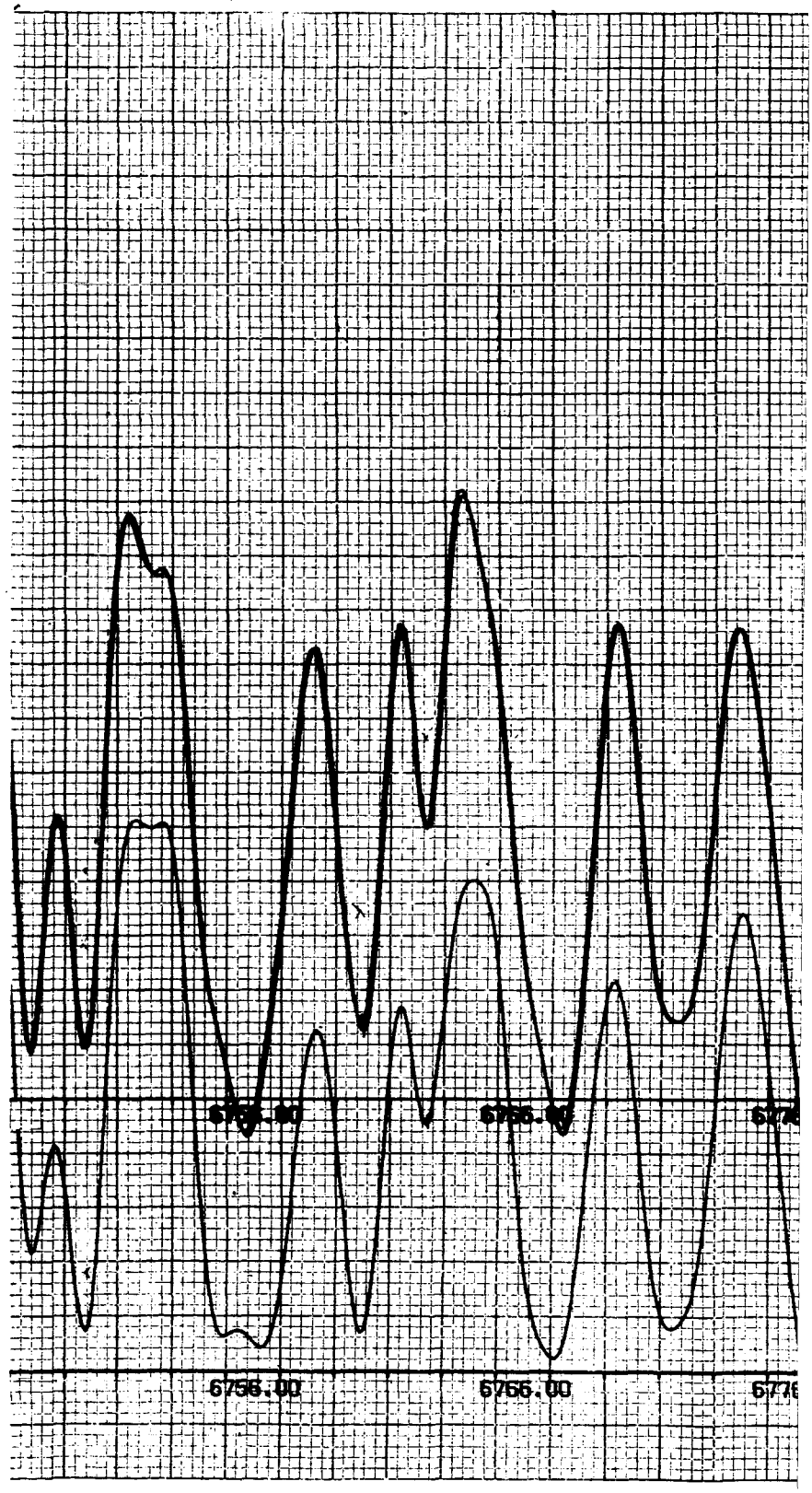
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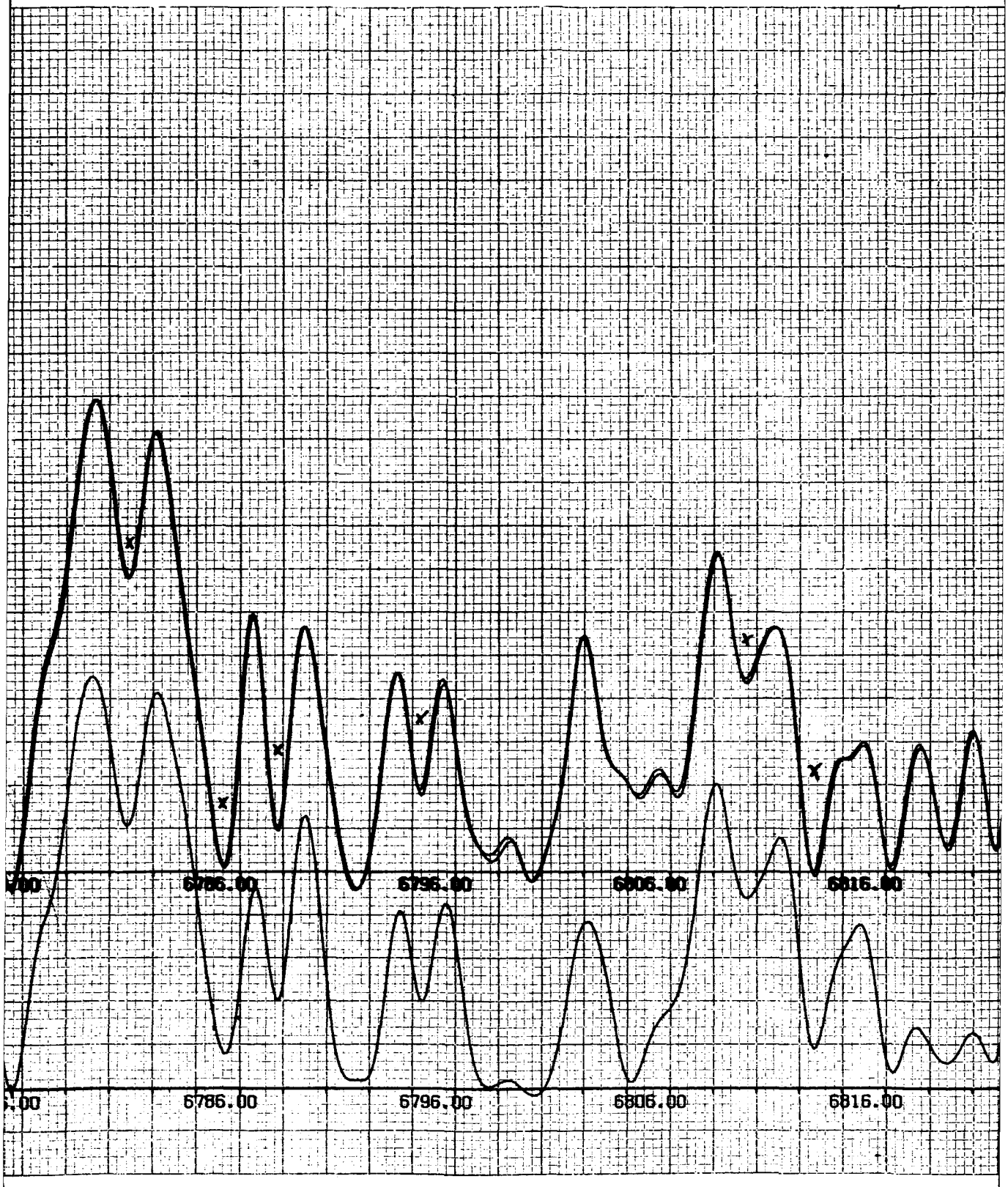

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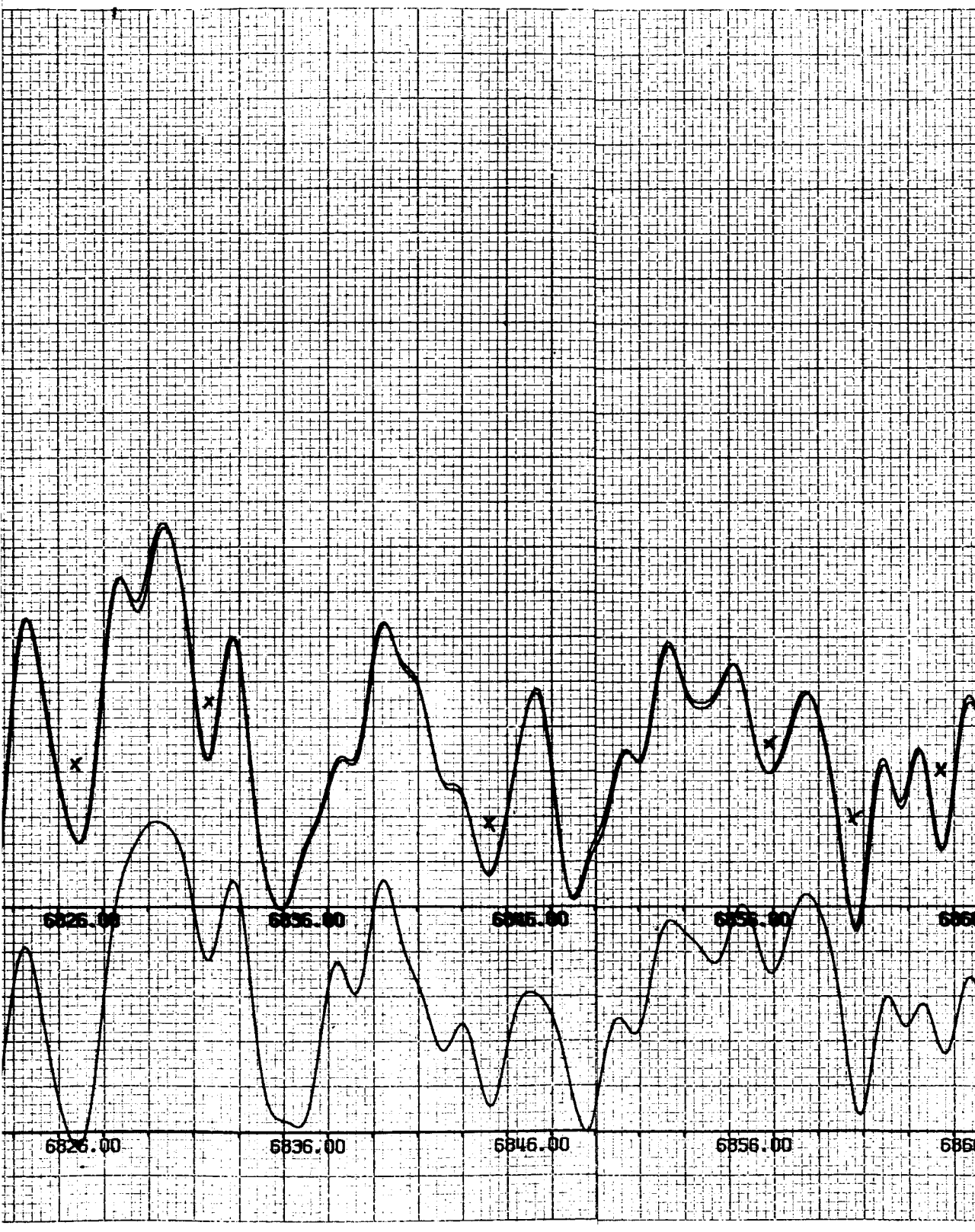
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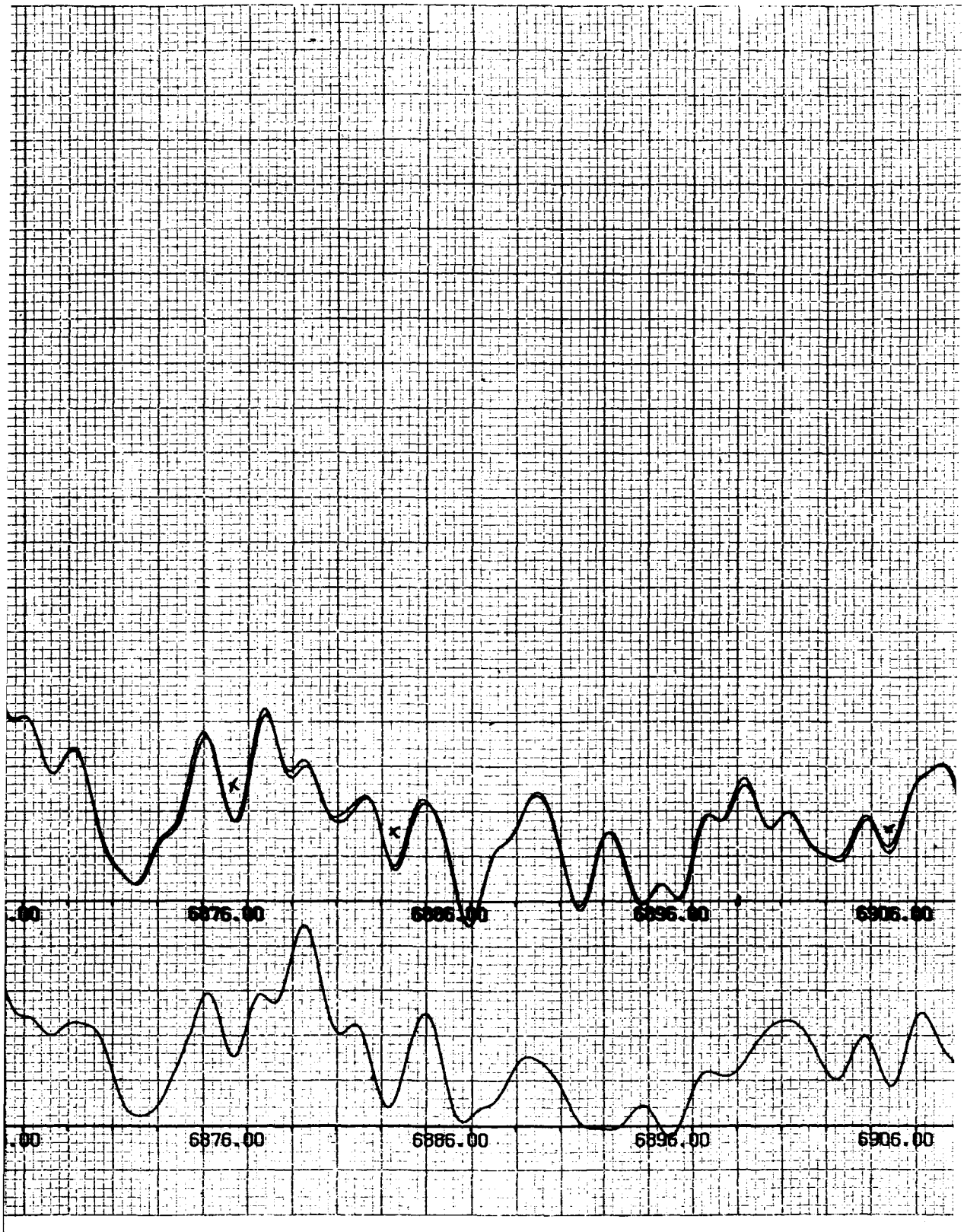
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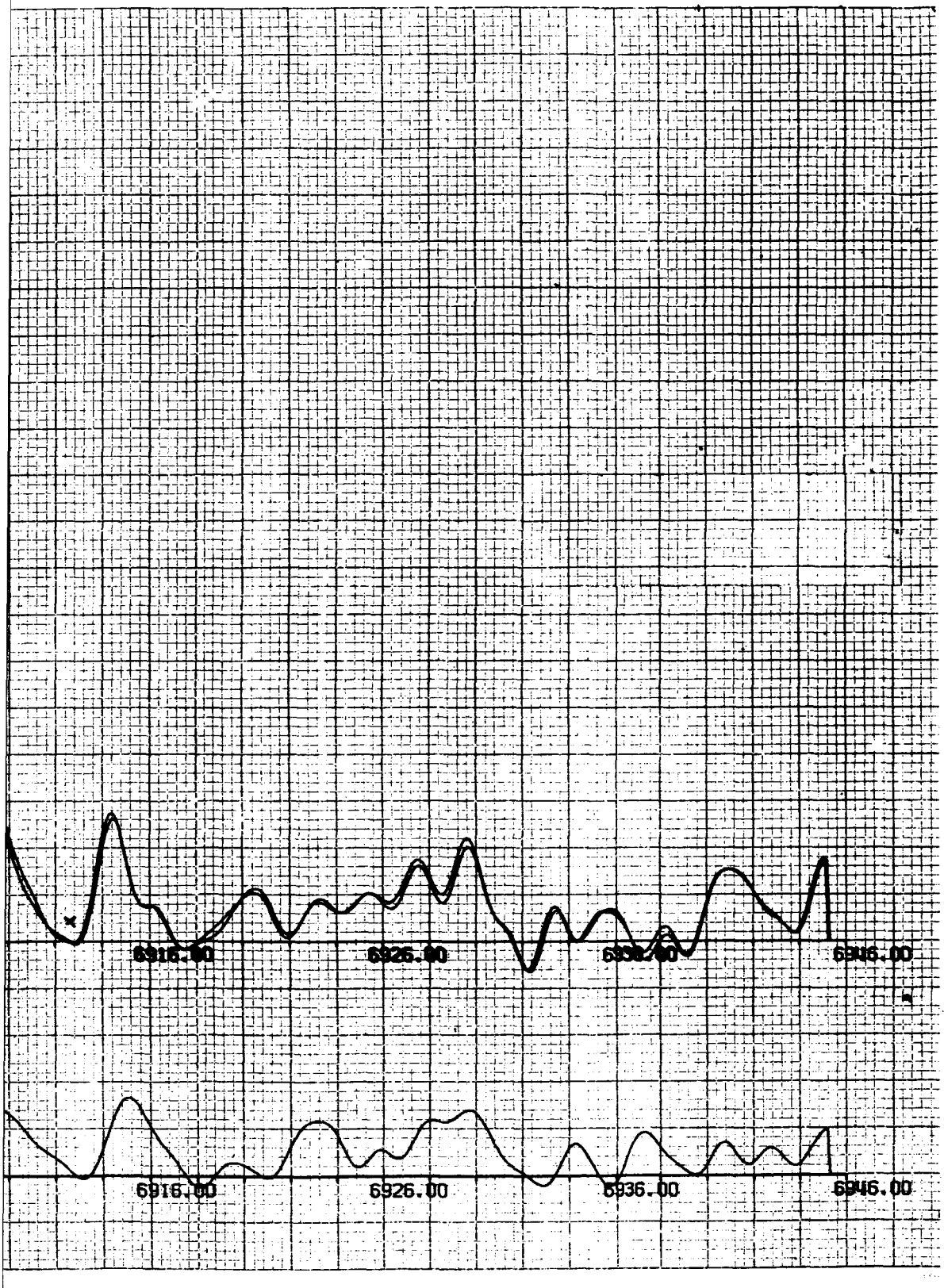
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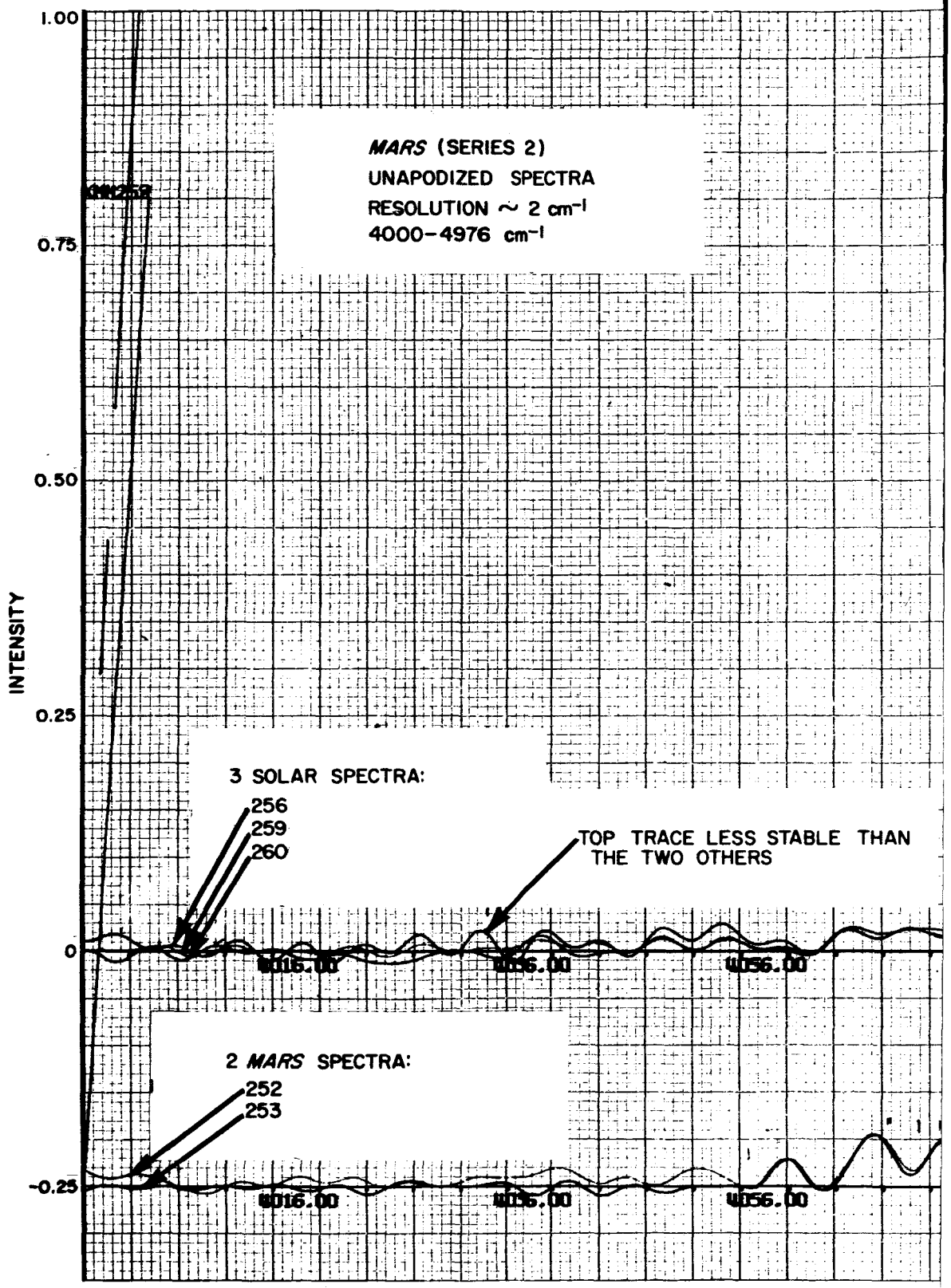
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UNAPODIZED SPECTRA
RESOLUTION ~ 2 cm⁻¹
4000-4976 cm⁻¹
3 SOLAR SPECTRA:
256
259
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TOP TRACE LESS STABLE THAN THE TWO OTHERS
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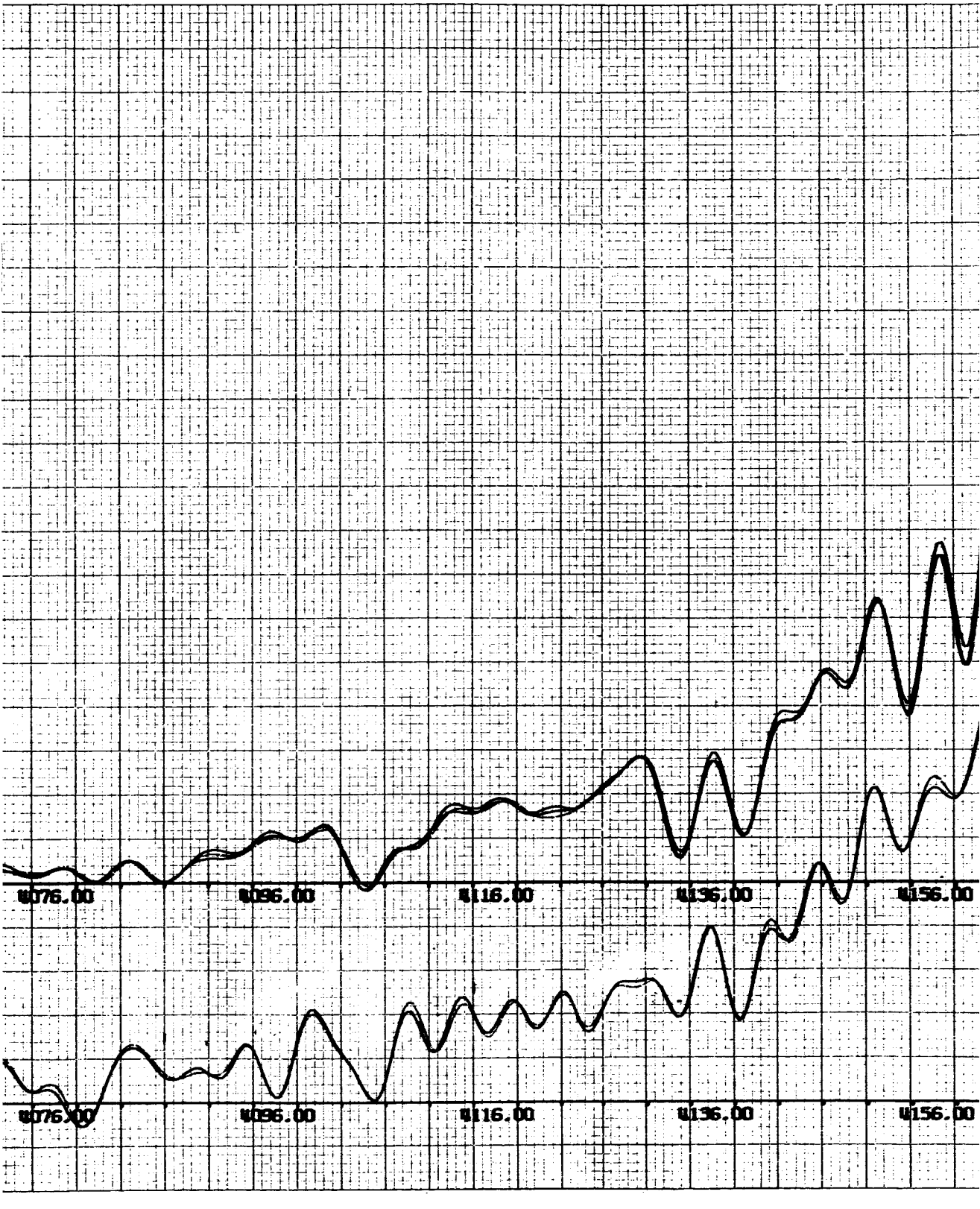
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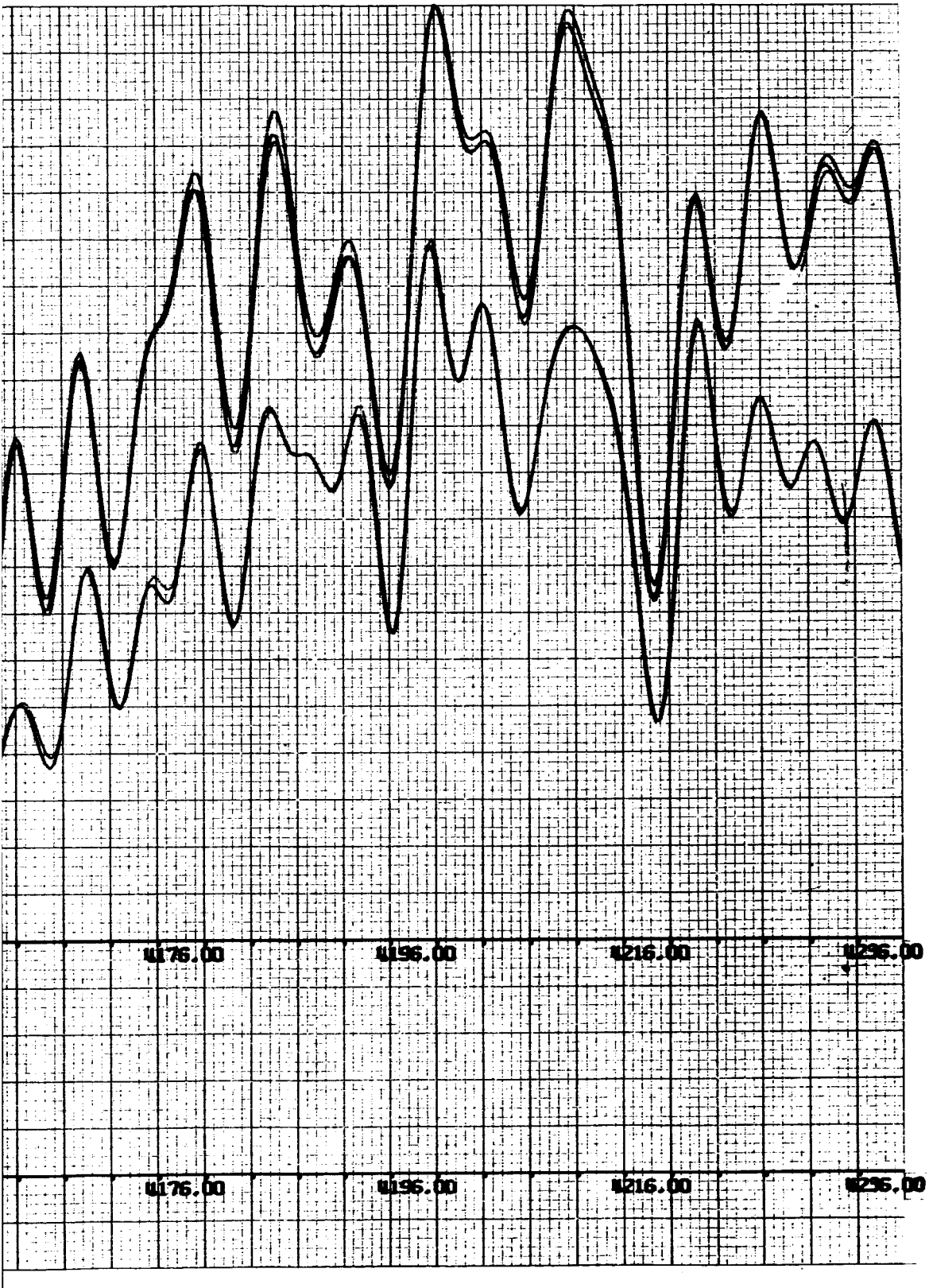
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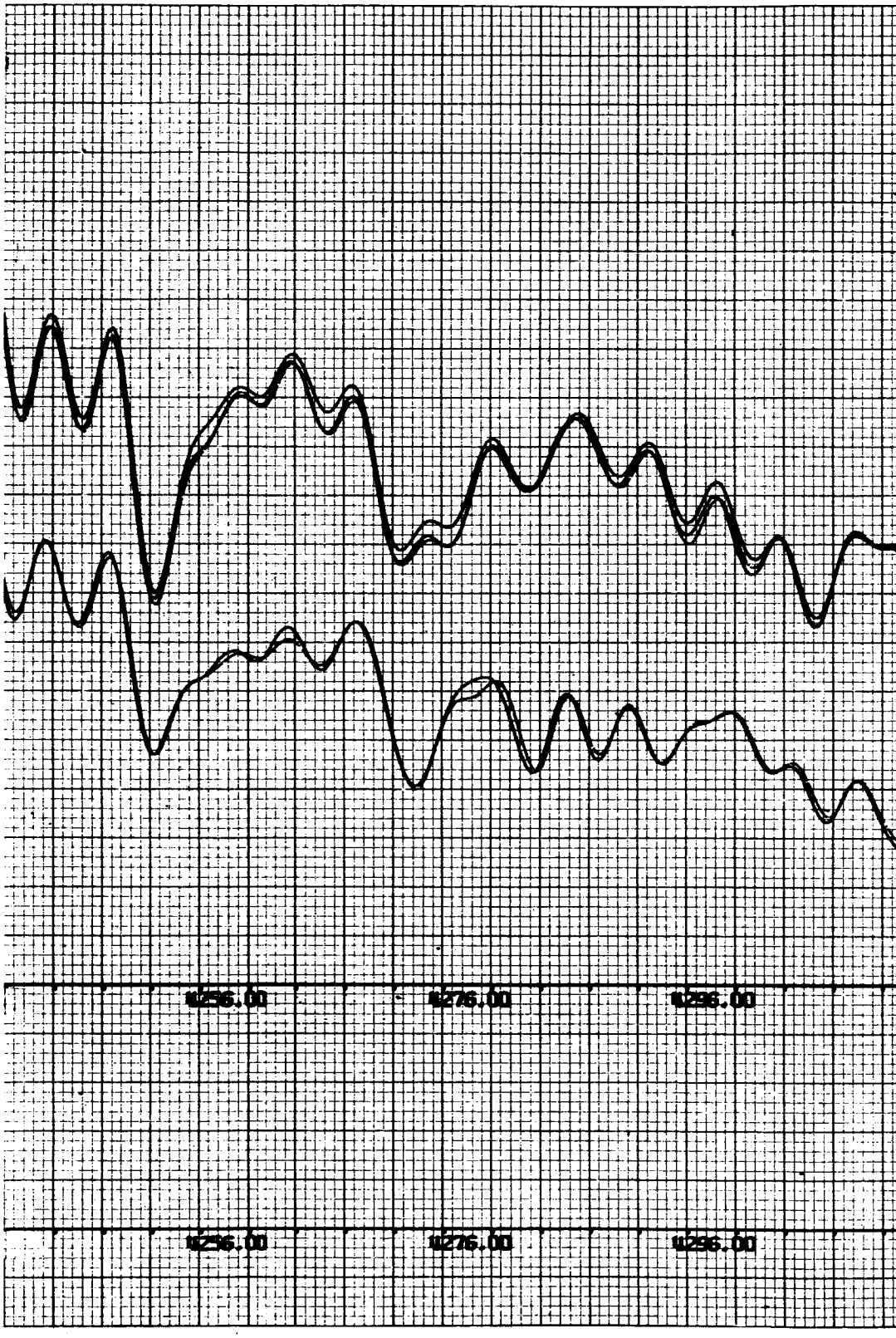
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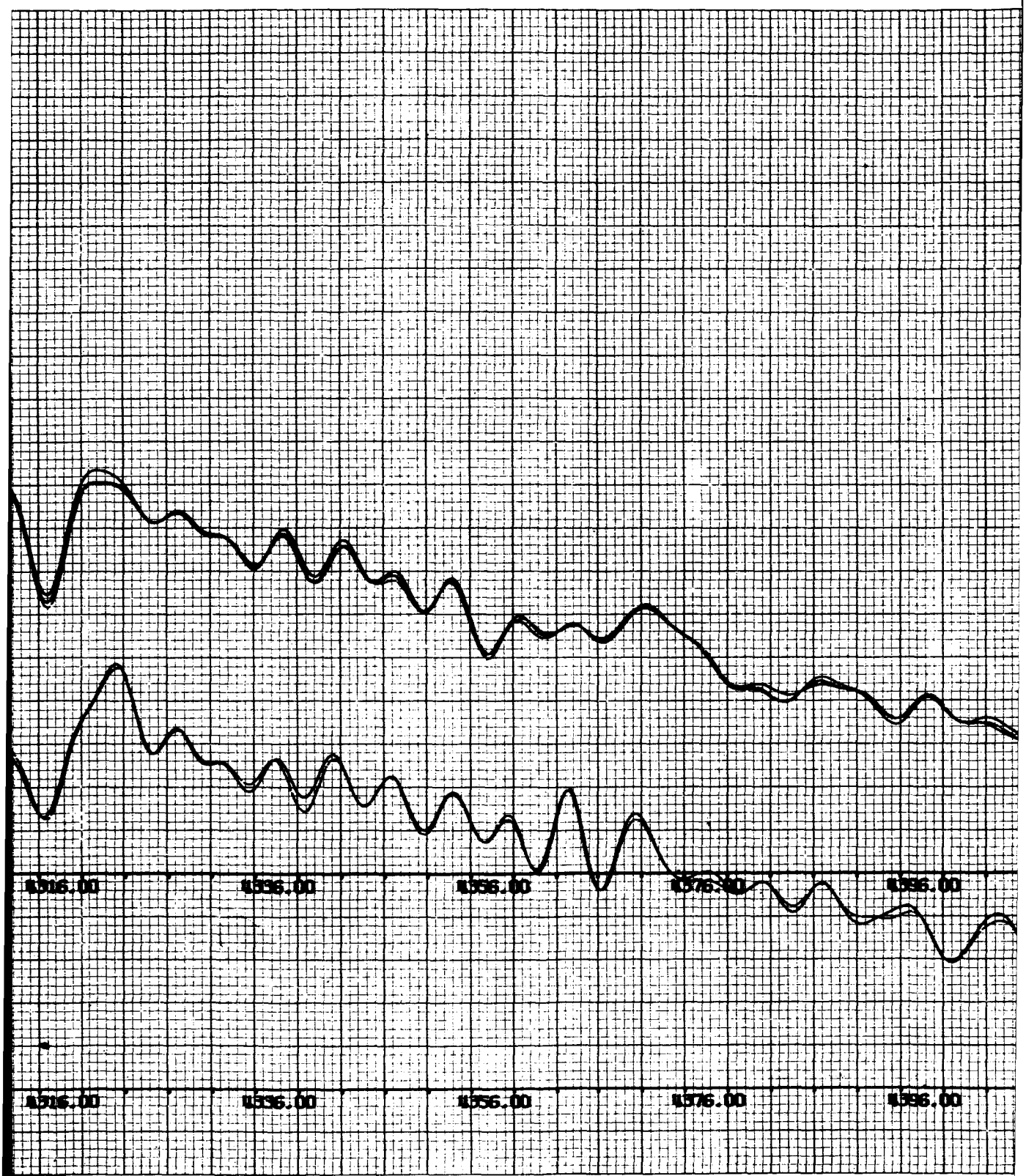
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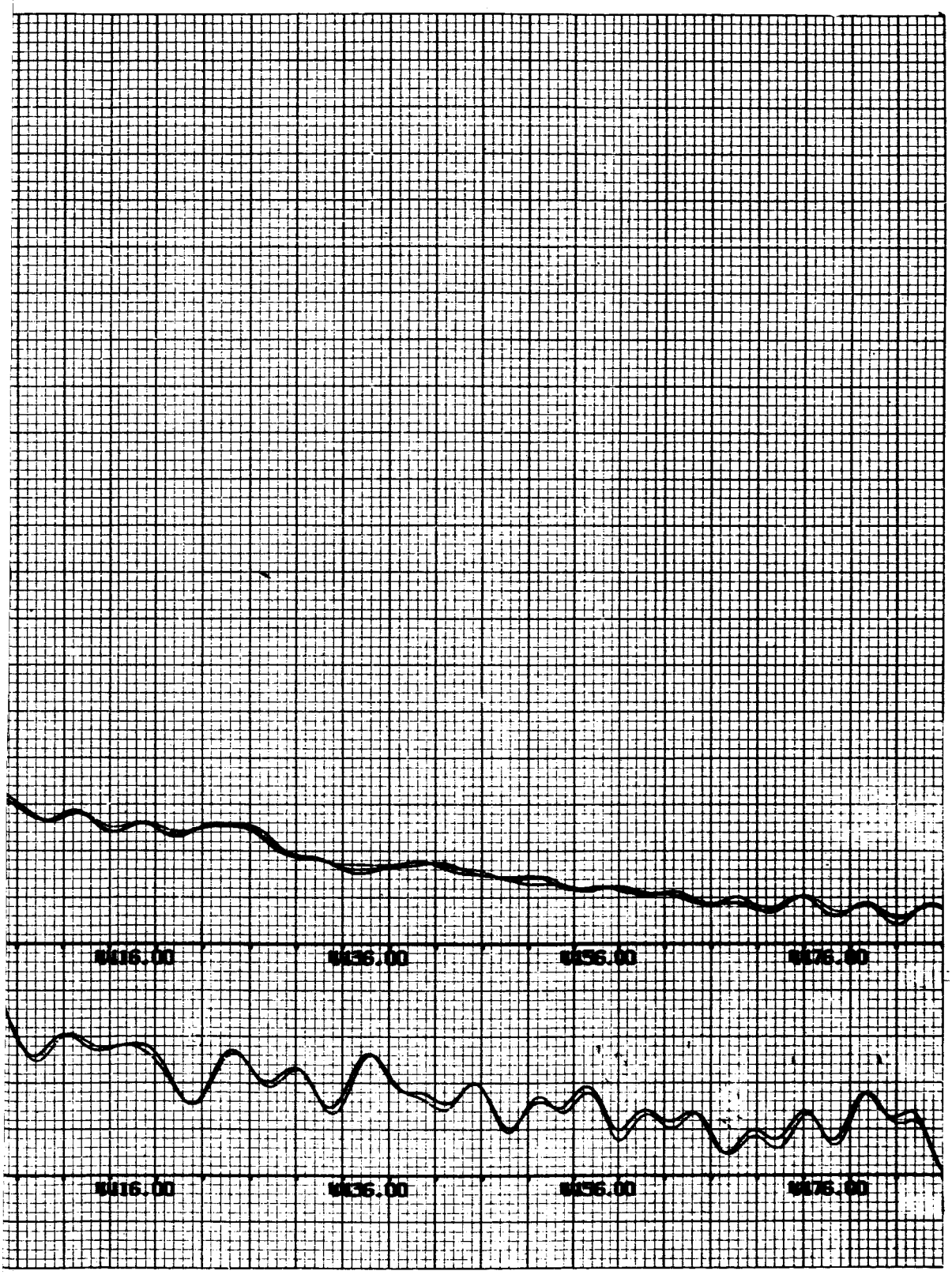

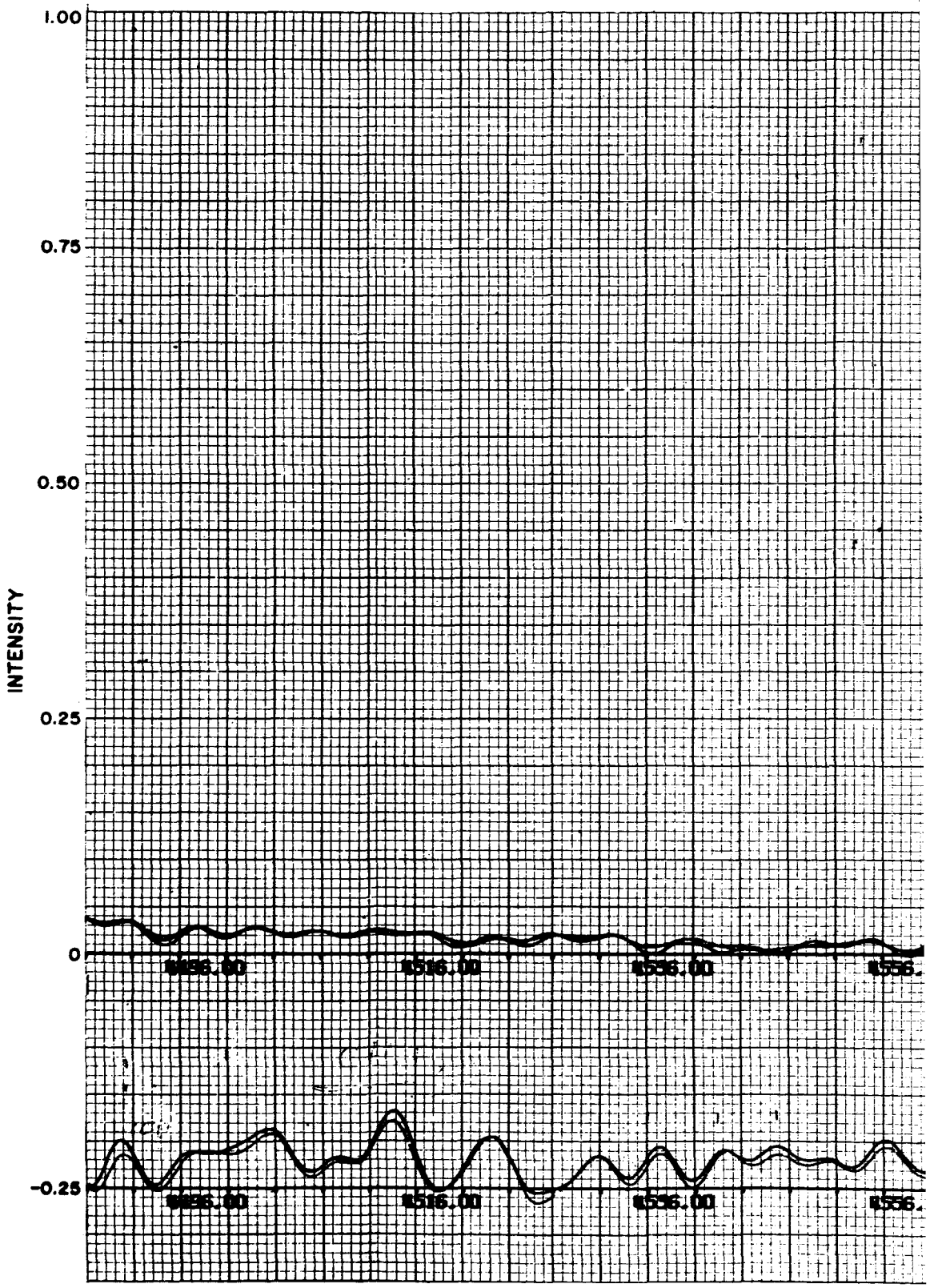
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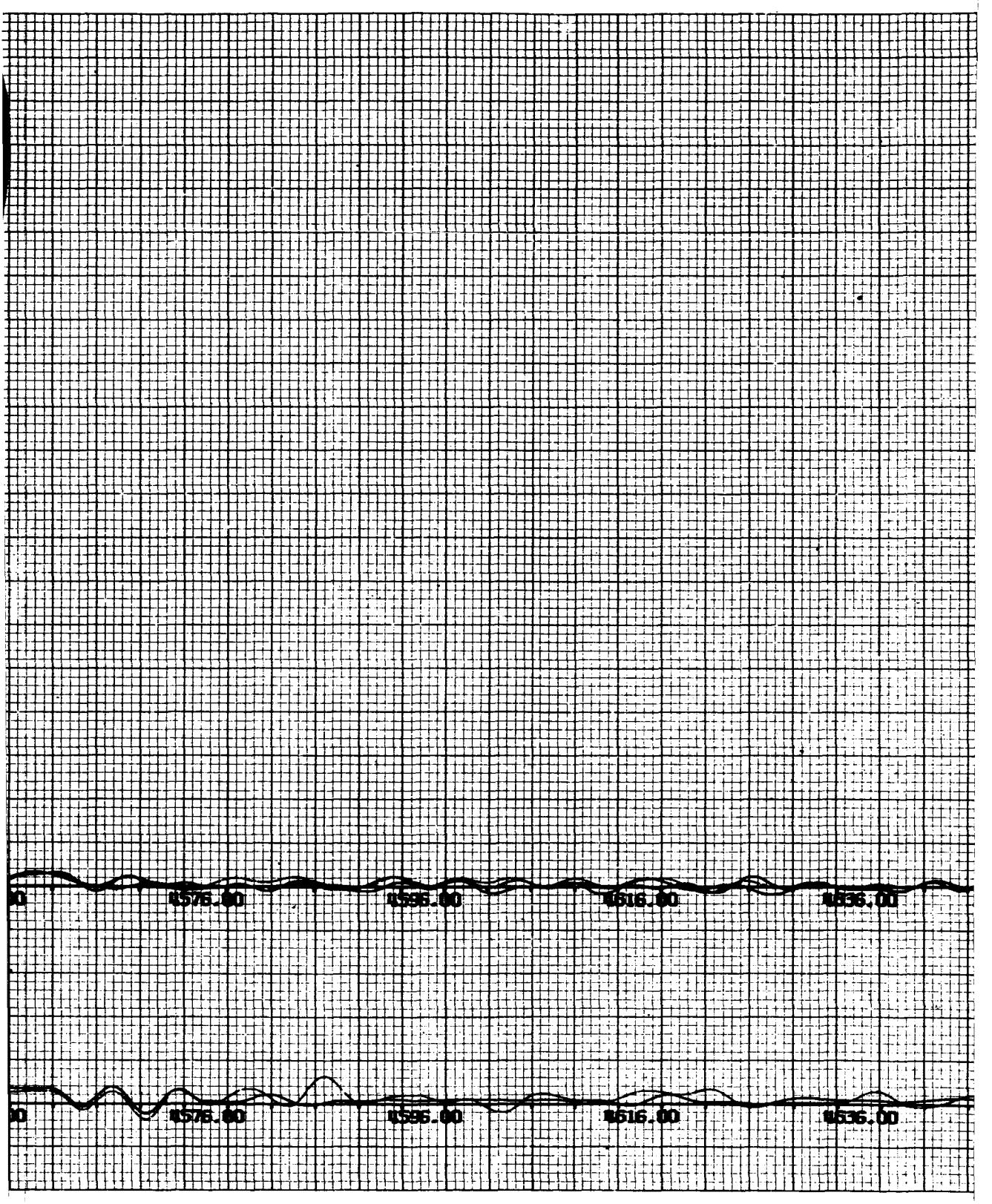
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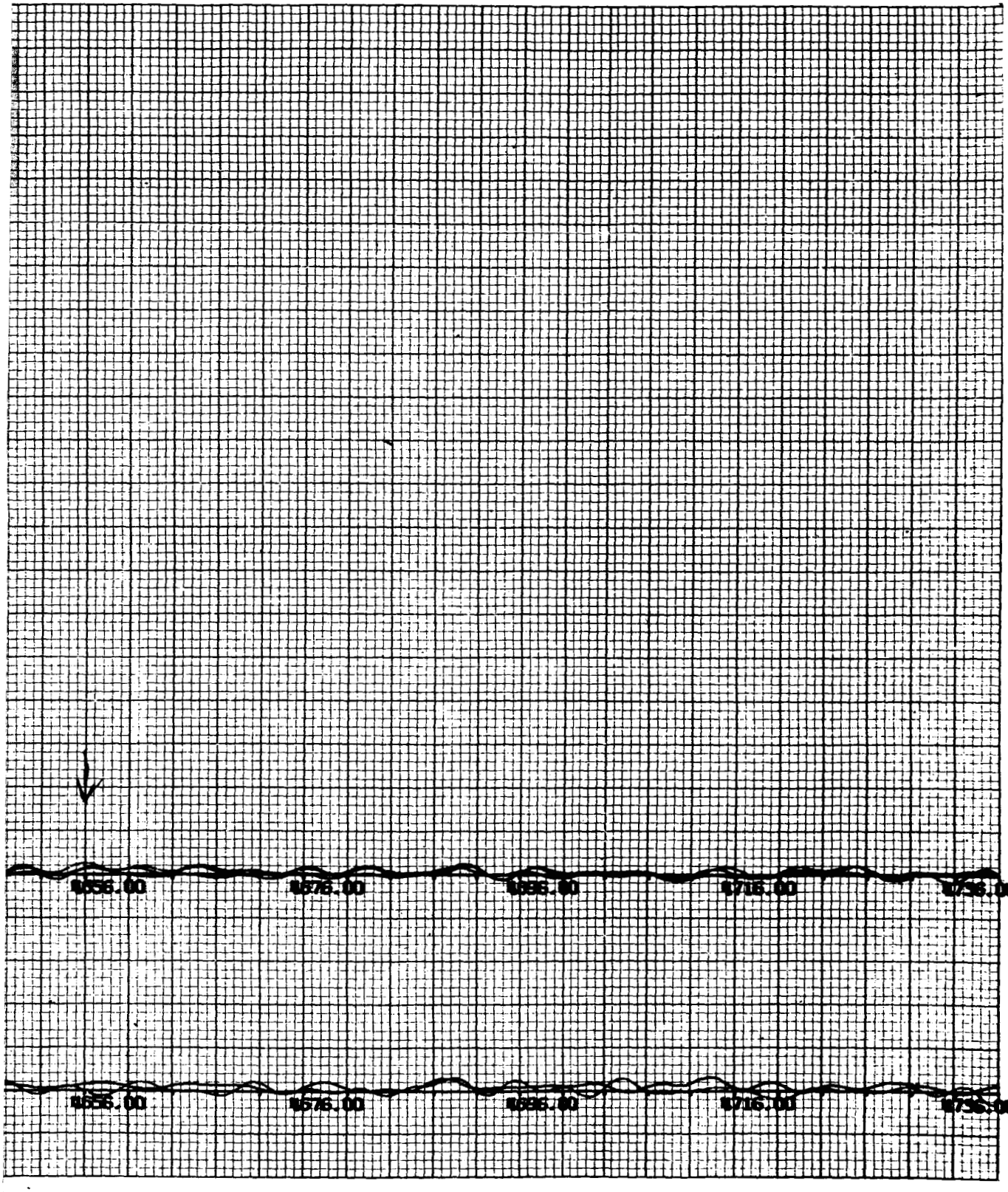
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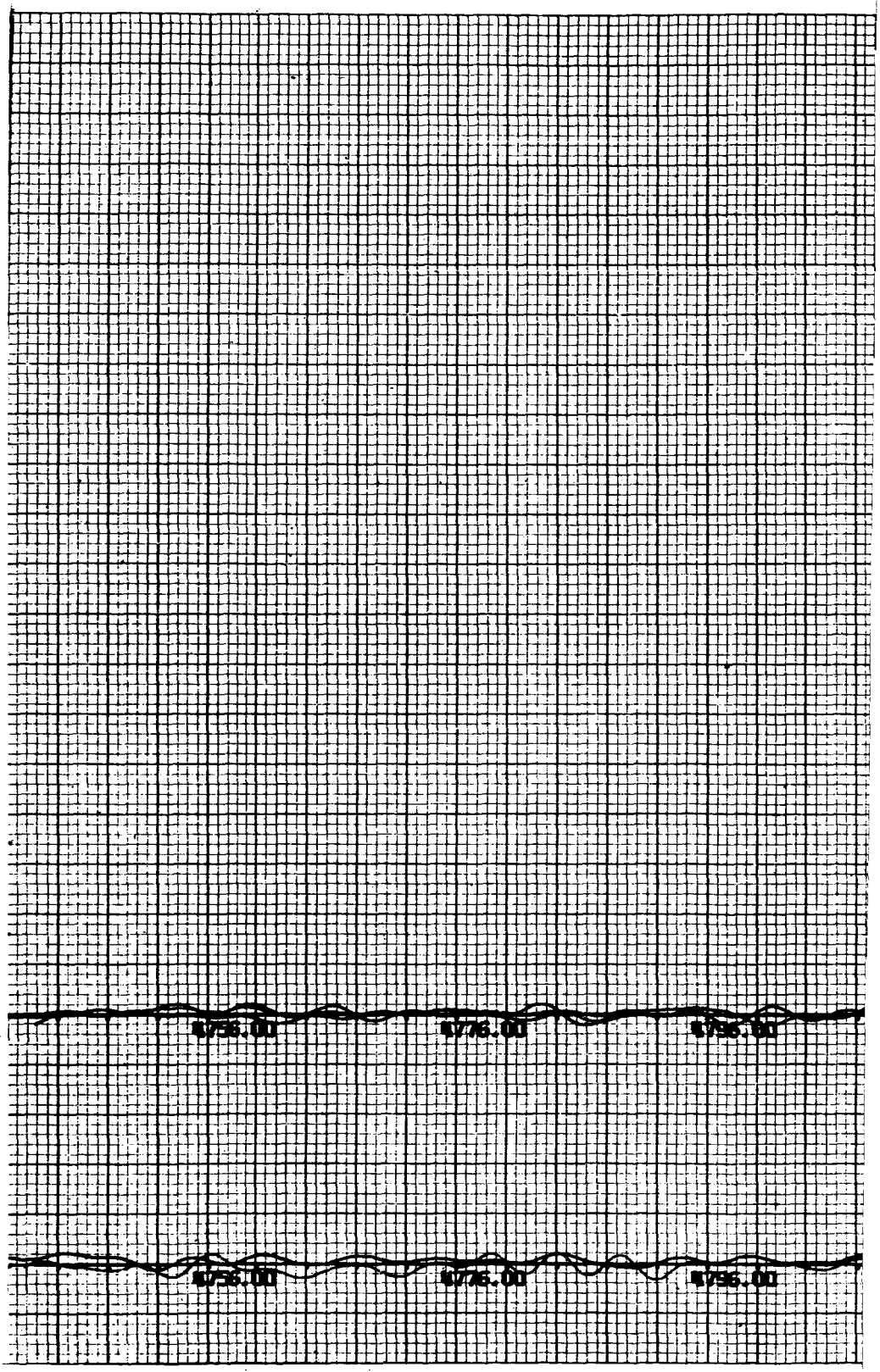
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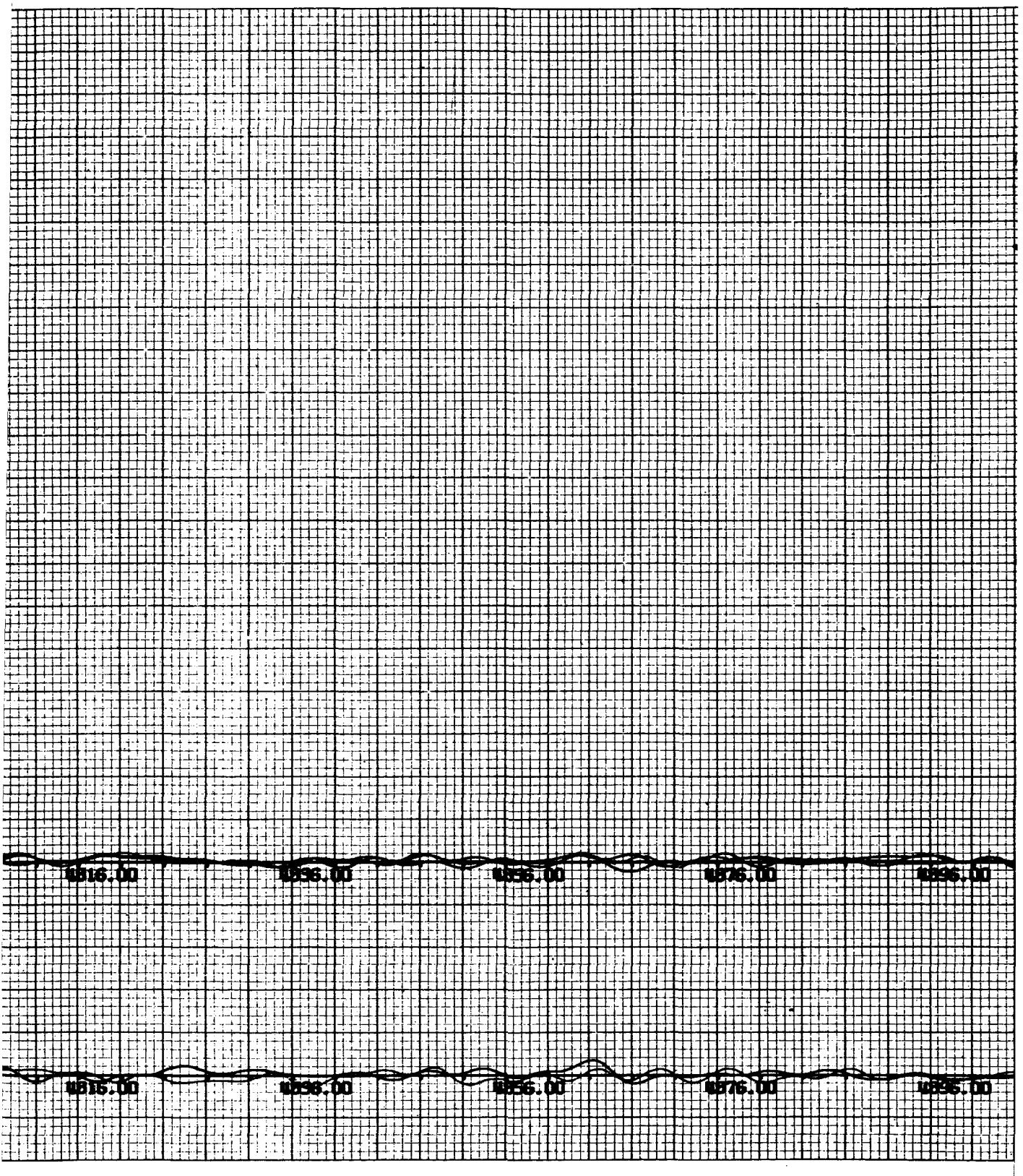
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